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EARTH OBSERVATORY SATELLITE SYSTEM DEFINITION STUDY

REPORT NO. 3: DESIGN/COST TRADEOFF STUDIES

- Appendix A: EOS Program WBS Dictionary
- Appendix B: EOS Mission Functional Analysis

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REPORT NO. 3: DESIGN/COST TRADEOFF STUDIES
- **Appendix A: EOS Program WBS Dictionary**
- **Appendix B: EOS Mission Functional Analysis**

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EARTH OBSERVATORY SATELLITE
SYSTEM DEFINITION STUDY

REPORT NO. 3
DESIGN/COST TRADE-OFF STUDIES
APPENDIX A

EOS PROGRAM WBS DICTIONARY
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APPENDIX A

INTRODUCTION

The numbers in the WBS dictionary that follows correspond to the numbers on the WBS chart on p. A-3/4.

WORK BREAKDOWN STRUCTURE DICTIONARY

1.0 EOS PROGRAM

The aggregate of hardware, computer software, services and data required to develop, produce, test, support and operate a space vehicle and its companion ground Data Management System for the purpose of earth observation and information dissemination.

1.1 PROGRAM MANAGEMENT NASA

The activity of NASA supporting engineering and project management functions, includes program level planning, direction and control.

1.2 DATA MANAGEMENT SYSTEM

The aggregate of hardware, computer software, services and data required to develop, produce, test, support and operate a ground based remote sensing data acquisition, data processing and user products generation system.

1.2.1 PROJECT MANAGEMENT

The aggregate of project management functions. It includes planning, direction, organization, controlling and reporting of the Data Management System 1.2. Included is the DMS Project Manager, Contracts Manager, and all managers under 1.2.2, 1.2.3, 1.2.4, 1.2.5, 1.2.6, 1.2.7, 1.2.8, 1.2.9, and 1.2.10.

1.2.1.1 PROJECT CONTROL

1.2.1.2 PROJECT ENG.

1.2.1.3 SUBCONTRACT MANAGEMENT

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1.2.1.4 PURCHASING CONTROL

1.2.2 SYSTEMS ENGINEERING AND INTEGRATION

The totality of the systems efforts involved in the establishment of the DMS. Included are the functional analysis and tradeoff studies to support initial design efforts in establishing the final DMS configuration, the installation and acceptance test planning and testing, initial training plans and training, and maintainability analysis of the DMS.

1.2.2.1 SYSTEM CONFIGURATION

1.2.2.2 ENGINEERING

1.2.2.3 INSTALLATION

1.2.2.4 ACCEPTANCE TEST

1.2.2.5 TRAINING

1.2.2.6 MAINTAINABILITY

1.2.3 DOCUMENTATION

The aggregate of the program documentation required for the proper design, development, procurement, manufacture, test, human use, and capability reporting of the DMS.

1.2.3.1 TECH MANUALS

1.2.3.2 SOFTWARE USER MANUAL

1.2.3.3 CAPABILITIES REPORT

1.2.3.4 SPARE PARTS LIST

1.2.3.5 MANUFACTURING DRAWINGS

1.2.3.6 INTERFACE DRAWINGS

1.2.3.7 TEST DOCUMENTATION

1.2.3.8 PERFORMANCES REPORT

1.2.3.9 TRAINING DOCUMENTATION

1.2.3.10 SPECIFICATIONS

1.2.4 CENTRAL DATA PROCESSING EQUIPMENT

The aggregate of the facilities and equipment required to manage the ground acquired remote sensing data and user requests for data including pre-processing, processing, storage, routing, controlling, generating and distributing and user products.

1.2.4.1 PRE-PROCESSING

That equipment utilized for the initial digital operations performed on all the recorded remote sensing data in order to prepare this data for the subsequent processing steps. This is the aggregate of equipments for procedures such as radiometric, one dimensional line-length adjustment, other calibration corrections. Included is the design, development and testing as a sub-system item.

1.2.4.2 PROCESSING EQUIPMENT

The aggregate of the equipment required to convert the standardized pre-processed digital data to the appropriate level of digital processed data in either the "uncorrected" or "corrected" form. The "uncorrected" form includes earth sensor scan correction and best estimates of ephemeris. "Corrected" form includes the refinements of the "uncorrected" form plus GCP's to improve ephemeris data. Included is the design, development, procurement, and testing as a sub-system.

1.2.4.3 PRODUCTS PRODUCTION

The aggregate of the equipment, over and above that classified under 1.2.4.2, required to produce first and second generation user products in both the digital and photographic areas. Included is the design, development, procurement and testing as a subsystem.

1.2.4.4 ARCHIVES

The total equipment required to store, access, and retrieve the raw remote sensing data tapes, pre-processed, and processed digital data, and the user products to be stored at the CDP under controlled and designated purge conditions. Included is the design, development, procurement, and testing as a subsystem.

1.2.4.5 INFORMATION MANAGEMENT SYSTEM EQUIPMENT

The aggregate of the unique equipment required to manage, control, coordinate, schedule, route, service the user community, and in general aid in decision making and reporting on the health, status, and activity of the CDP. Included is the design, procurement, and test as a sub-set of equipments.

1.2.4.6 INTERFACING SYSTEMS EQUIPMENT

The totality of the unique equipment required to interface the CDP to the other ground systems such as the Project Control Center, the user community, other NASA service areas. Included is the design, procurement and test as a sub-system.

1.2.4.7 FACILITIES:

The aggregate of the "brick and mortar", primary power, air conditioning requirements and other service areas and floor space required to establish a functioning CDP.

1.2.5 LOW COST GROUND STATION EQUIPMENT:

The aggregate of the equipment required for a self-contained ground facility to directly acquire remote sensing data from the spacecraft process, process the data as required and produce the appropriate user product. Included is the design, development, procurement, and test and integration of the facility.

1.2.5.1 RF/IF

1.2.5.2 HIGH RATE RECORDER

1.2.5.3 PROCESSING

1.2.5.4 DISPLAY AND CONTROLS

1.2.6 DATA ACQUISITION:

The aggregate of the equipment and modification required to existing or planned NASA facilities for the acquisition of the remote sensing data transmitted from the spacecraft. Included is the design, development, procurement, and test as a sub-system.

1.2.6.1 TDRSS GROUND STATION MODIFICATION

1.2.6.2 PRIMARY GROUND STATION MODIFICATION

1.2.7 SOFTWARE:

The aggregate of all the computer programs required to acquire remote sensing data, process the data, maintain and troubleshoot the equipment, develop new routines, control the CDP and its interfaces and service the user community. Included are the efforts involved in producing, checking, and documenting these programs.

1.2.7.1 CONTROL DATA PROCESSING

1.2.7.2 LOW COST GROUND STATION

1.2.7.3 DATA ACQUISITION

1.2.7.4 UTILITIES

1.2.7.5 ON LINE/OFF LINE DIAGNOSTICS

1.2.7.6 INFORMATION MANAGEMENT SYSTEM

1.2.8 SPARE PARTS:

The totality of the spares required to support the DMS for a five year cycle. Excluded are any spares that might be required for initial installation and checkout and the Low Cost Ground Station.

1.2.8.1 TOOLS

1.2.8.2 PARTS

1.2.9 EXPENDABLES:

The aggregate of the digital and photographic expendable material required to operate the DMS and service the user community for a five year period. Excluded are expendables for initial installation and checkout and the Low Cost Ground Station.

1.2.9.1 DIGITAL

1.2.9.2 PHOTO

1.2.10 OPERATION AND MAINTENANCE:

All the DMS contractor and NASA personnel required to operate, maintain, and service the user community for a five year period. Excluded are the Low Cost Ground Station personnel.

1.2.10.1 GROUND STATION

1.2.10.2 CENTRAL DATA PROCESSING

1.3 INSTRUMENTS:

The hardware associated with the collection of earth sensed data. It includes the design, development, production, test, delivery to the spacecraft assembly site, and its support through spacecraft launch.

1.3.1 LRM INSTRUMENT:

The aggregate of instruments (sensors) selected for the Land Resources Mission.

1.3.1.1 THEMATIC MAPPER (TM):

All the efforts required to design, develop and test a nadir-looking optomechanical scanner capable of acquiring multispectral imagery in seven channels ranging from 0.5 to 12.6 um, including a thermal- IR channel. Imagery format is digital, each "frame" covers an area of 185 KM x 185 KM with a spatial resolution of 30m x 30m. Data rate is approximately 100 MBS. Included is instrument fabrication and its GSE.

1.3.1.2 FIVE BAND MULTI-SPECTRAL SCANNER (MSS):

All the efforts to design and develop a nadir-looking optomechanical scanner capable of acquiring multispectral imagery in five bands, four of the existing as used on ERTS plus a thermal-IR band. Frame size is 185 KM x 185 KM, resolution is 79m x 79m. Data output is digital with a data rate of about 15 MBS. Included is instrument fabrication and GSE.

1.3.2 FOLLOW ON INSTRUMENTS:

The aggregate of instruments that are considered candidates for EOS missions following the completion of the LRM. Included is design, development, production, testing and test equipment. (Instrument GSE)

1.3.2.1 PASSIVE MULTICHANNEL MICROWAVE RADIOMETER (PMMR):

All the effort required to design and develop an all weather measurements instrument for sea state, sea temperature and atmospheric moisture. Included is instrument fabrication and GSE.

1.3.2.2 SYNTHETIC APERTURE RADAR (SAR):

All the effort required to design and develop an imaging radar operating at x-band and L-band frequencies consisting of transmitter - modulator electronics and side looking antenna capable of imaging a swath width of about 60 KM at a resolution of 30m x 30m. Included is instrument fabrication and GSE.

1.3.2.3 SYNCHRONOUS EARTH OBSERVATORY SATELLITE (SEOS)

All the efforts required to design and develop a geostationary platform (on an EOS) for monitoring short lived and dynamic phenomena on a continuous periodic or command basis. More than one instrument may be included. Included is platform fabrication and GSE.

1.3.2.4 SEA SATELLITE (SEASAT):

All the efforts required to design and develop an ocean dynamics monitor platform (on an EOS) for mapping the topography of the ocean surface by means of altimetry. More than one instrument may be included. Included is platform fabrication and GSE.

1.3.2.5 HIGH RESOLUTION POINTABLE IMAGER (HRPI):

All the efforts required to design, develop and test an optomechanical scanner capable of + 40 offset pointing and acquiring multispectral imagery in four channels ranging rom 0.5 to 1.1, μm. Imagery format is digital, each frame covers an area of 45 KM x 45 KM with a spatial resolution of 10m x 30m. Data rate is about 100 MBS. Included is instrument fabrication and its GSE.

1.3.2.6 SOLAR MAXIMUM MISSION (SMM).

All the efforts to design and develop a sun observing instrument to obtain images and spectra of the sun from IR to Gamma rays. Included is instrument fabrication and GSE.

1.3.2.7 DATA COLLECTION SYSTEM (DCS):

All the effort required to design and develop receiving equipment aboard the EOS S/C to acquire the data from the platforms and route it through the S/C downlink communications.

1.4 FLIGHT OPERATIONS AND SERVICES:

All effort and materials directly associated with operations of the Spacecraft 1.7.3 comprising flight tracking, control and orbital operations, with retrieval and resupply for shuttle period.

1.4.1 GROUND COMMAND CONTROL AND TRACKING:

The aggregate of equipment software and services that results in the placement and operation of the S/C in orbit. Excluded is the effort of launching the S/C into orbit under Launch System 1.5.

1.4.1.1 TELEMETRY TRANSMISSION

All the NASA efforts associated with S/C data transmission between the S/C to primary ground stations to control center and/or sensor data processing center, including microwave, hardline and physical transmittal of tapes.

1.4.1.2 COMPUTER PROGRAM:

All the NASA efforts associated with the design, development and checkout of computer programs in support of S/C mission operations for command control and tracking of the S/C from the mission control center and ground stations. Also included are programs required for S/C data analysis. Excluded is software developed under Software 1.2.7.

1.4.1.3 MISSION PLANNING:

All the NASA efforts, associated with the planning of each EOS mission in terms of the requirements for ground command, control and tracking, including the operation planning during the mission life.

1.4.1.4 MISSION OPERATIONS CONTROL CENTER

All the efforts, NASA and contractor, including hardware, its design, development and fabrication, involved in the operation of the Project Control Center, and in the actual operation of the S/C in orbit. Excluded is the facility under Mission Operations Control Center 1.7.6.3.

1.4.1.5 DATA ANALYSIS:

All the NASA efforts required to analyze S/C data to ascertain its operational capability and corrective action generation for uplink commands.

1.4.1.6 NETWORK MODIFICATIONS:

The hardware and associated efforts for modifications to NASCOM as a result of the EOS program.

1.4.1.7 GFSC OPERATIONS SUPPORT:

All the effort subcontracted by NASA to assist them in EOS GSFC operations in support of 1.4.1.1 through 1.4.1.4

1.4.2 RETRIEVAL RESUPPLY AND OPERATIONS SUPPORT

All the efforts and materials required to conduct; (1) EOS retrieval operations using the shuttle to return an EOS to ground and; (2) EOS resupply of replaceable items in orbit, using the shuttle.

Included are the shuttle operations support during the retrieval or resupply operation. Excluded are the S/C hardware costs under S/C Refurbishment 1.7.8 and Spares 1.7.5.1

1.5 LAUNCH SYSTEM:

The aggregate of launch vehicle (L/V), hardware for interfacing S/C and payload to L/V, launch operations and launch.

1.5.1 LAUNCH VEHICLE (L/V):

All the effort involved with acquiring a L/V, with adapter stages if any, the LV and adapter stage cost and any L/V GSE including that installed at L/V site.

1.5.2 SHROUD AND ADAPTER:

All the effort required to design, develop and fabricate a S/C shroud and S/C to L/V adapter for a particular EOS S/C.

1.5.3 OPERATIONS, SUPPORT AND SERVICING:

All the effort and material required to launch as EOS from pre-launch checkout, at the launch site, to "handover" to the Project Control Center. Excluded is the GSE under 1.7.4 used in support of launch.

1.5.4 PAYLOAD INTERFACES:

The hardware required to interface the payload to pre-launch c/o and launch. This includes the inferface design, development, fabrication, and test.

1.6 SHUTTLE RESUPPLY PROJECT:

The hardware that provides in orbit exchange of replaceable subsystem S/C items and their storage during ascent and descent of the shuttle. It includes the design, development, production, test and support.

1.6.1 MANIPULATOR SYSTEM:

The manipulator system required to service an EOS from the shuttle cargo bay while in orbit. Includes design, development, fabrication and test of the system. Excluded is the effort for shuttle demonstration flight under 1.7.7.4. This system is presently under study by the Canadian consortium of SPAR, DSMA, RCA/Canada and CAE.

1.6.2 STOWAGE SYSTEM:

The system aboard the shuttle that secures an EOS for launch or return to earth. Includes design, development, fabrication and test.

1.7 SPACECRAFT PROJECT:

The aggregate of installed equipment and structure comprising a total vehicle for placement in space including mission peculiar. It includes analysis, design, development, production, testing, support, supporting facilities and S/C refurbishment for the shuttle period.

1.7.1 PROJECT MANAGEMENT:

The aggregate of project management functions. It includes planning, direction, organization, controlling and reporting of the spacecraft project 1.7. It also includes activities needed to assure that planning is accomplsished by organizations directly responsible for the complementary functions of launch, payload, flight operations and shuttle resupply. Included is the S/C Project Manager, Contracts Manager, Business Manager and all managers under 1.7.2, 1.7.3, 1.7.4, 1.7.5, 1.7.6, 1.7.7 and 1.7.8.

1.7.1.1 PROJECT CONTROL:

All administrative efforts associated with planning, coordinating, controlling and approval actions designed to accomplish overall project objectives. It includes the effort necessary to negotiate and administer the contract with NASA.

1.7.1.2 CONFIGURATION MANAGEMENT:

All effort required to identify, control and audit the configuration of hardware and computer programs.

1.7.1.3 DATA MANAGEMENT:

All effort required to identify, acquire, control, store, retrieve and disseminate contract data items.

1.7.1.4 COST PERFORMANCE MANAGEMENT:

All effort required to identify, organize, budget, work authorize, cost accumulate all project activities, and reporting of all project costs.

1.7.2 SYSTEM ENGINEERING AND INTEGRATION:

The aggregate of functional analysis of the S/C to identify preliminary design requirements, trade off studies to support preliminary design effort in establishing final S/C configuration, interface studies for system integration, defining the control center, S/C reliability, maintainability, quality assurance requirements and overall safety.

1.7.2.1 SYSTEM ANALYSIS:

This task involves system analyses studies for the S/C preliminary design, considering overall system weight and power and the allocation of total system error performance among affected subsystems. It also includes the effort of Support System analysis and tradeoffs necessary to determine and refine support requirements and characteristics. This effort also includes Instrument Accommodation analysis.

1.7.2.2 SYSTEM INTEGRATION:

Perform the integration analyses functions required to produce a S/C system which meets the operational needs. These functions assure operational compatibility among program elements, associated systems, subsystems and components. It includes the integration of launch vehicle and payload interface design with the S/C.

1.7.2.3 TEST REQUIREMENTS DEFINITION:

Determine test requirements for all levels of S/C testing as well as the requirements of GSE test. This includes developmental, qualification and acceptance.

1.7.2.4 CONTROL CENTER DEFINITION:

All efforts required to define and develop a control center for the S/C. This includes definition of the interface requirements between the center, ground stations, S/C data processing, users as well as all software requirements for control center operation.

1.7.2.5 RELIABILITY:

Conduct a reliability program for the S/C which includes development of a reliability plan, provide design review and monitoring, reliability predictions, failure mode and effect analysis, and establishment and maintenance of a failure review board.

1.7.2.6 SAFETY:

Perform hazards, design safety and operations hazard analyses for S/C, GSE and facilities from initial production through launch.

1.7.2.7 QUALITY ASSURANCE:

Establish a quality assurance program that utilizes existing applicable procedures. Participate in producibility studies, change control, development tests, non-conformance control, inspection, test planning, contamination and corrosion control planning, calibration of test equipment and material review board.

1.7.2.8 MAINTAINABILITY:

Develop a maintainability program plan, determine qualitative and quantitative maintainability requirements for the S/C, S/S components and GSE, develop design criteria, participate in seller proposal evaluations, monitor seller maintainability activities, perform trades offs for alternate designs, analyze failures to identify maintainability problems.

1.7.3 SPACECRAFT:

The installed subsystems comprising the housing for carrying the instruments, 1.3, into space. It includes the design, development, production, assembly, and test of both the individual S/S and the S/C. It excludes the S/C testing performed under 1.7.7.

1.7.3.1 BASIC COMM. AND DATA HANDLING MODULE:

The assembled basic communications and data handling hardware of the S/C that (1) interfaces with operations at ground stations and control center, (2) provides S/C housekeeping data handling, signal conditioning, computing hardware for S/C control (ACS Functions). It includes design, development, production and testing as a subsystem module.

1.7.3.2 BASIC EPS MODULE:

The assembled hardware that provides and distributes electrical power to the S/C. Includes the basic battery set and regulation devices. It also includes design, development, production and testing as a subsystem module.

1.7.3.3 BASIC ACS MODULE:

The assembled hardware directly associated with the attitude and control of the S/C. Also includes design, development, production and testing as a subsystem module. It excludes the computer requirement which is under 1.7.3.1.

1.7.3.4 BASIC ON BOARD SOFTWARE:

The computer programs that provide (1) the attitude control subsystem with command responses, (2) S/C control from ground commands, and (3) all programs required for mission operation.

1.7.3.5 STRUCTURE/THERMAL:

The assembled structure that houses and supports the S/S and the hardware that maintains and controls the required thermal environment of the S/C. It includes design, development, production and testing.

1.7.3.6 INSTRUMENT MISSION PECULIARS AND STRUCTURE:

The aggregate of hardware consisting of Wide Band Data Handling and Communication and Inst. Support Structure. In addition, the effort involved with On Board Data Compaction is also included as well as hardware design, development, production and testing.

1.7.3.7 MISSION PECULIAR EPS:

The additional batteries installed in the basic EPS Module, peculiar to a particular mission, and in addition the solar arrays and associated drives. It includes design, development, production and testing.

1.7.3.8 MISSION PECULIAR ACS:

The reaction wheels and magnetic torquer bars installed in the basic ACS module. It includes their design, development, production and testing.

1.7.3.9 MISSION PECULIAR ORBIT ADJUST:

The assembled hardware for a particular mission that provides adjustment of the S/C within a selected orbit, as part of the OA/OT housing. It includes design, development, production and testing.

1.7.3.10 MISSION PECULIAR PNEUMATICS:

The assembled hardware for a particular mission that provides adjustment of the S/C within a selected orbit, as part of the OA/OT housing. It includes design, development, production and testing.

1.7.3.11 MISSION PECULIAR ORBIT TRANSFER:

The assembled hardware for a particular mission that will transfer the S/C from one distinct orbit to another and is part of the OA/OT housing. It includes design, development, production and testing.

1.7.3.12 MISSION PECULIAR ON-BOARD SOFTWARE:

The computer programing specifically designed for a particular mission, in addition to the resident S/C programs. Excluded is software that is "uplinked" to the S/C for special mission commands 1.4.1.2. Includes the software design, development and test.

1.7.3.13 SHUTTLE FLIGHT SUPPORT SYSTEM:

The installed hardware which cradles and secures the S/C within the Shuttle cargo bay, including the retention ring and rotating docking platform. It includes design, development, production and testing.

1.7.3.14 INTEGRATION AND TESTS:

All effort required to integrate and assemble the S/C assemblies and S/S modules into an entire S/C vehicle. Includes detailed planning, test plans, expendable hardware, items consumed during test, recurring integration and test equipment in addition to the spacecraft GSE 1.7.4. Excludes non-recurring integration and tests identified under 1.7.7.

1.7.3.15 MISSION PECULIAR COMMUNICATION AND DATA HANDLING:

The additional memory capacity and precision clock that is installed in the basic Communication and Data Handling Module for particular missions. It includes design, development, production and test.

1.7.4 SPACECRAFT GSE:

The aggregate of hardware and software required to maintain, care for and checkout the S/C and S/S while not directly engaged in the performance of its mission. It includes design, development, production and testing. Excludes supporting activities after hardware and software acceptance, such as Integration and Test 1.7.3.14.

1.7.4.1 ELECTRICAL GSE:

All hardware to permit evaluation and monitor and control of the S/C and its S/S for functional, environmental, and integrated system testing for factory to launch operations. It includes design, development fabrication and test.

1.7.4.2 MECHANICAL GSE:

All hardware required to inspect, assemble, test, handle, protect and transport the S/C and its S/S during factory to launch operations. It includes design, development, fabrication and test.

1.7.4.3 FLUID GSE:

All hardware required for evacuation and testing of S/C fuel lines and tanks, providing a proper atmosphere for S/C pressurized systems and for shipping environment during S/C and S/S transportation. It includes design, development, fabrication and test.

1.7.5 LOGISTICS SUPPORT:

All effort associated with providing spares, training, technical publications, transportation and handling, inventory control and warehousing.

1.7.5.1 SPARES:

All efforts required to provide spares, including the cost of the spares.

1.7.5.2 TRAINING:

All efforts required to provide training for S/C test, launch and orbital operations. Includes the cost of all training material such as texts and notes, but excludes hardware costs. All training is considered on the job type and operational hardware and equipment will be used.

1.7.5.3 PUBLICATIONS:

All efforts required to produce seven technical manuals; (1) Systems Manual, (2) Ground Controllers Console; (3) Project Operations Console; (4) Interface Equipment; (5) Test and Integration Station Manual; (6) System Design Manual; and (7) Ground Station/ EOS Interface Manual.

1.7.5.4 TRANSPORTATION AND HANDLING:

All efforts required to identify the S/C, S/S, and GSE transportation and handling requirements and the preparation of a Transportation and Handling Plan. Also assure compliance during transportation. Included is the cost of the transportation. Excluded is the hardware provided under Mechanical GSE 1.7.4.2.

1.7.5.5 INVENTORY CONTROL AND WAREHOUSING:

All effort associated with providing storage and issuance and control of parts.

1.7.6 FACILITIES:

All effort required to develop and maintain the physical facilities in support of the S/C from factory through launch and its recovery, refurbishment and relaunch during the shuttle period.

1.7.6.1 MANUFACTURING/ENGINEERING:

All efforts and material required to provide engineering, S/C, S/S and GSE assembly housing area, with appropriate physical services, such as power. The S/C and S/S will be assembled in a 10,000 type clean room.

1.7.6.2 LAUNCH:

All the efforts and materials required to provide a physical facility for the purpose of pre-launch checkout and the launch of the S/C and its launch vehicle. It includes the effort and cost of services such as power but excludes all test equipment provided under 1.7.4.

1.7.6.3 MISSION OPERATIONS CONTROL CENTER (MOCC)

All the effort and materials required to provide a physical facility, including the equipment within, for monitoring, analyzing and commanding the EOS S/C during its orbital mission. Excluded is the ground station effort under 1.2.6.3 and the cost of the equipment under 1.4.1.4.

1.7.6.4 STDN:

All the efforts, materials and equipment necessary for modification of the STDN where required for an EOS mission.

1.7.6.5 RECOVER AND REFURBISHMENT:

All the efforts and materials required to provide a physical facility for the purpose of EOS recovery and refurbishment during the shuttle operations period. All equipment, in addition to that provided under S/C GSE 1.7.4, is also included.

1.7.6.6 SITE ACTIVATION:

All the effort required to prepare factory and launch sites for S/C checkout, including preparation of ICD's, S/C - GSE compatibility plans and procedures and initial validation of all GSE prior to use with the S/C.

1.7.7 VEHICLE LEVEL TEST:

The aggregate of services and hardware required to perform non-recurring development/qualification type vehicle level testing. The hardware is that peculiar to a particular test and does not include that provided under S/C GSE 1.7.4.

1.7.7.1 DEV/QUAL TEST OPERATIONS:

All the effort required to perform and support the development and qualification testing of an entire S/C. Includes the detailed planning, support data reduction and reports.

1.7.7.2 DEV./QUAL TEST HARDWARE:

The hardware associated with development and qualification of the S/C. It includes its design and fabrication. Excluded is the equipment to support these tests that are provided under S/C GSE 1.7.4.

1.7.7.3 ORBITAL TEST HARDWARE:

The non-recurring effort, materials and flight equipment necessary to refurbish the qualification model S/C and prepare it for a shuttle flight demonstration. It includes design and fabrication.

1.7.7.4 ORBITAL TEST OPERATIONS:

The total effort in preparation for and support of the shuttle flight demonstration from initial checkout after S/C refurbishment in 1.7.7.3 and its return after shuttle orbital demonstration. It includes deactivation and/or storage of the S/C.

1.7.8 SPACECRAFT REFURBISHMENT:

The aggregate of S/C hardware and efforts, on a recurring basis, to refurbish a S/C after return by the shuttle. Excluded are the supportive efforts under Retrieval Resupply and Operations Support 1.4.2., S/C GSE 1.7.4.

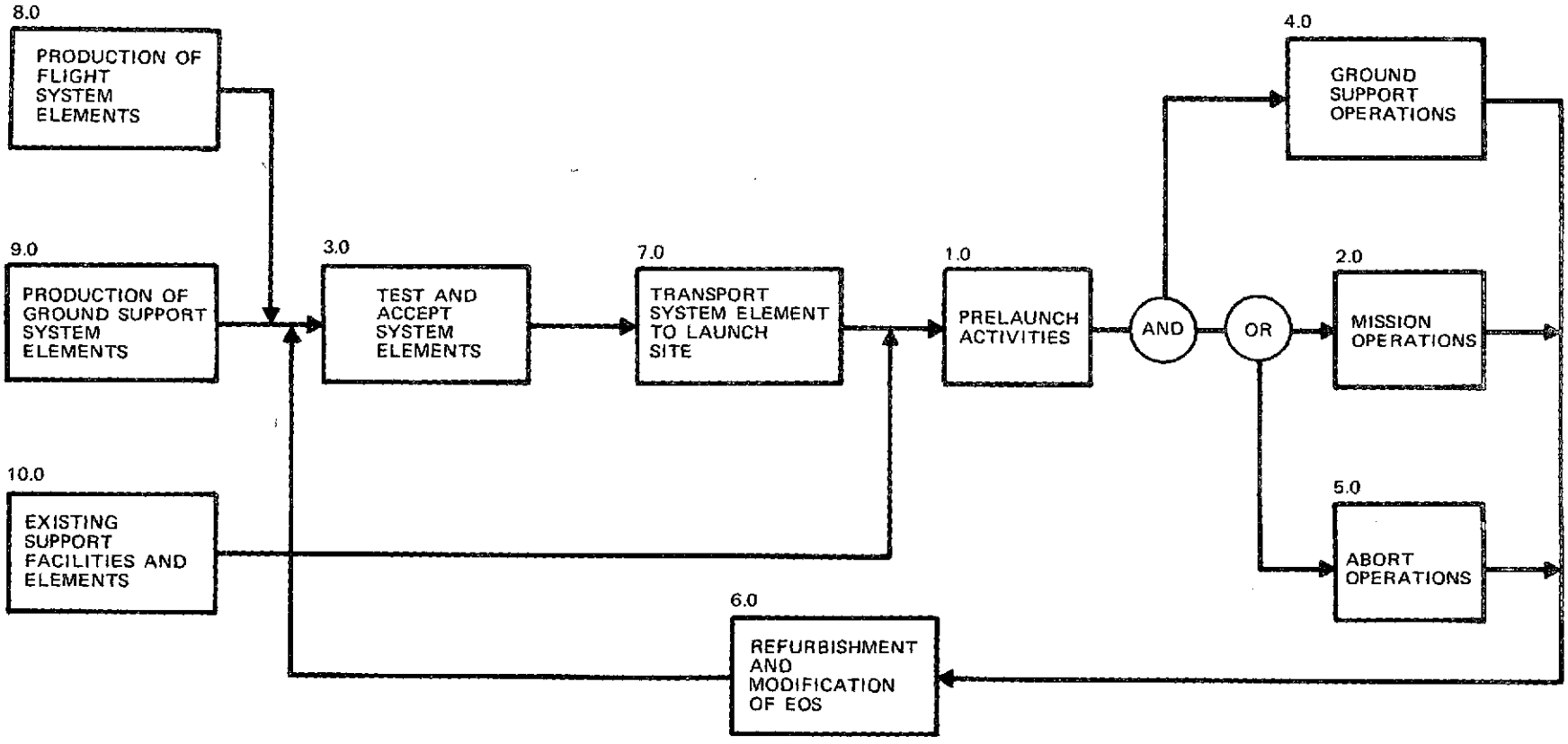
APPENDIX B

APPENDIX B

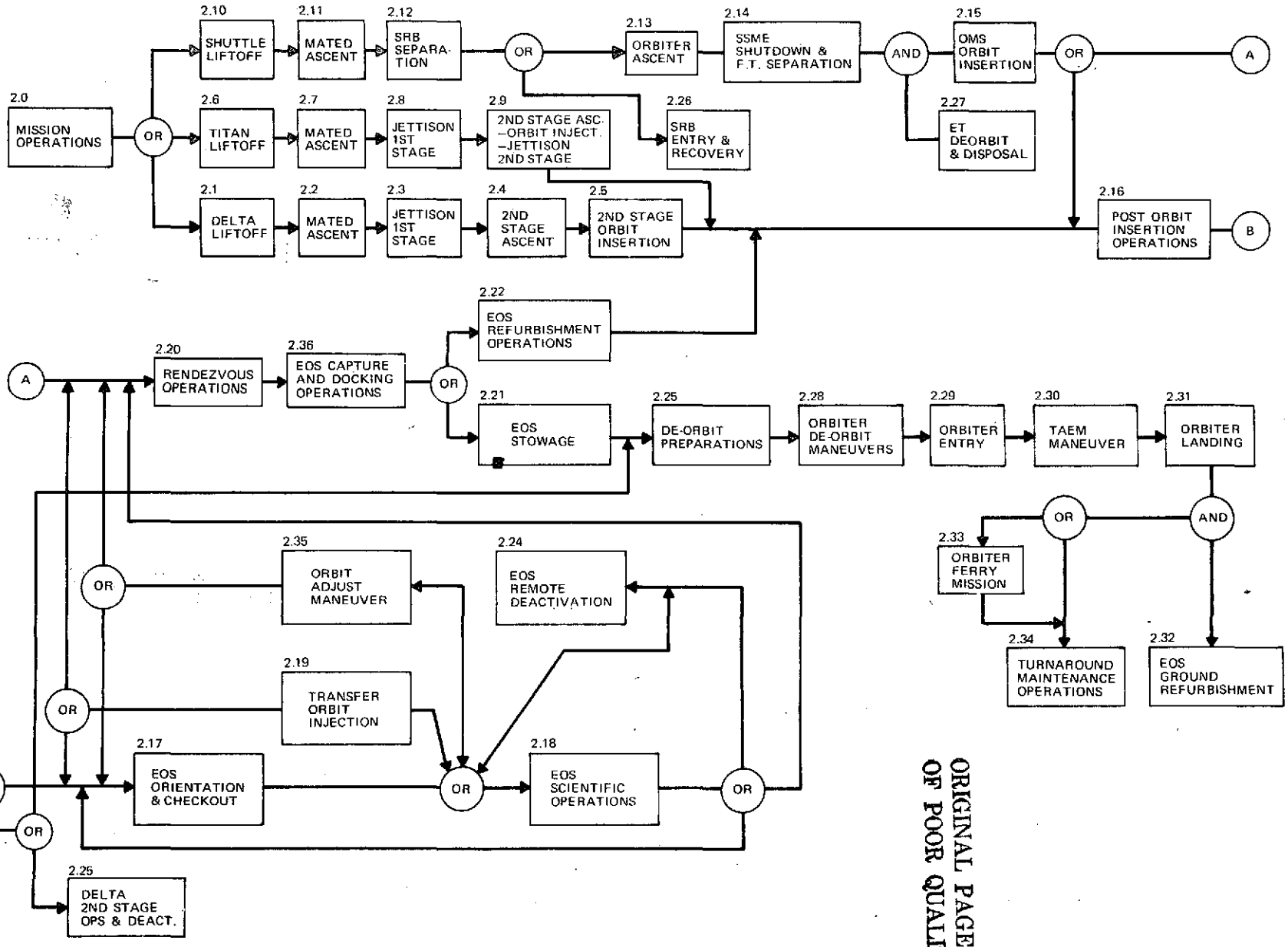
EOS MISSION FUNCTIONAL ANALYSIS

The purpose of this Functional Analysis was to develop the operations for three typical EOS Missions, Delta, Titan and Shuttle launched. These functions generated requirements which are incorporated into the Requirements Document (appendix C).

Functions were determined for the top program elements, and the mission operations, function 2.0, was expanded to level I functions. Selection of 10 level I functions for further analysis to level II and III functions were based on concern for the EOS operations and associated interfaces. These 10 level I functions are identified in the EOS Functional Analysis Top Level diagram (page B-2) by heavy borders around the functions.

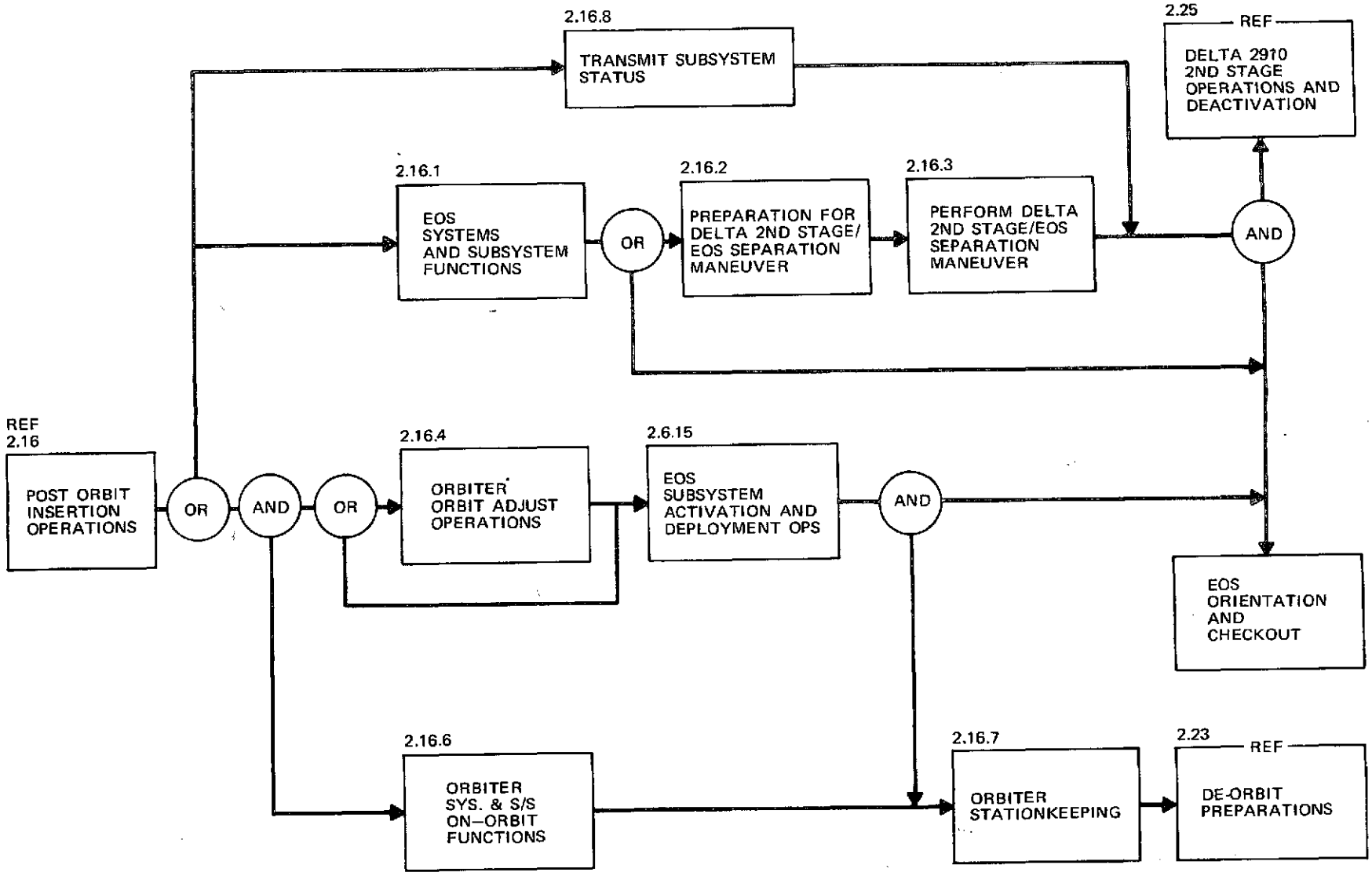


EOS Functional Analysis Top Level

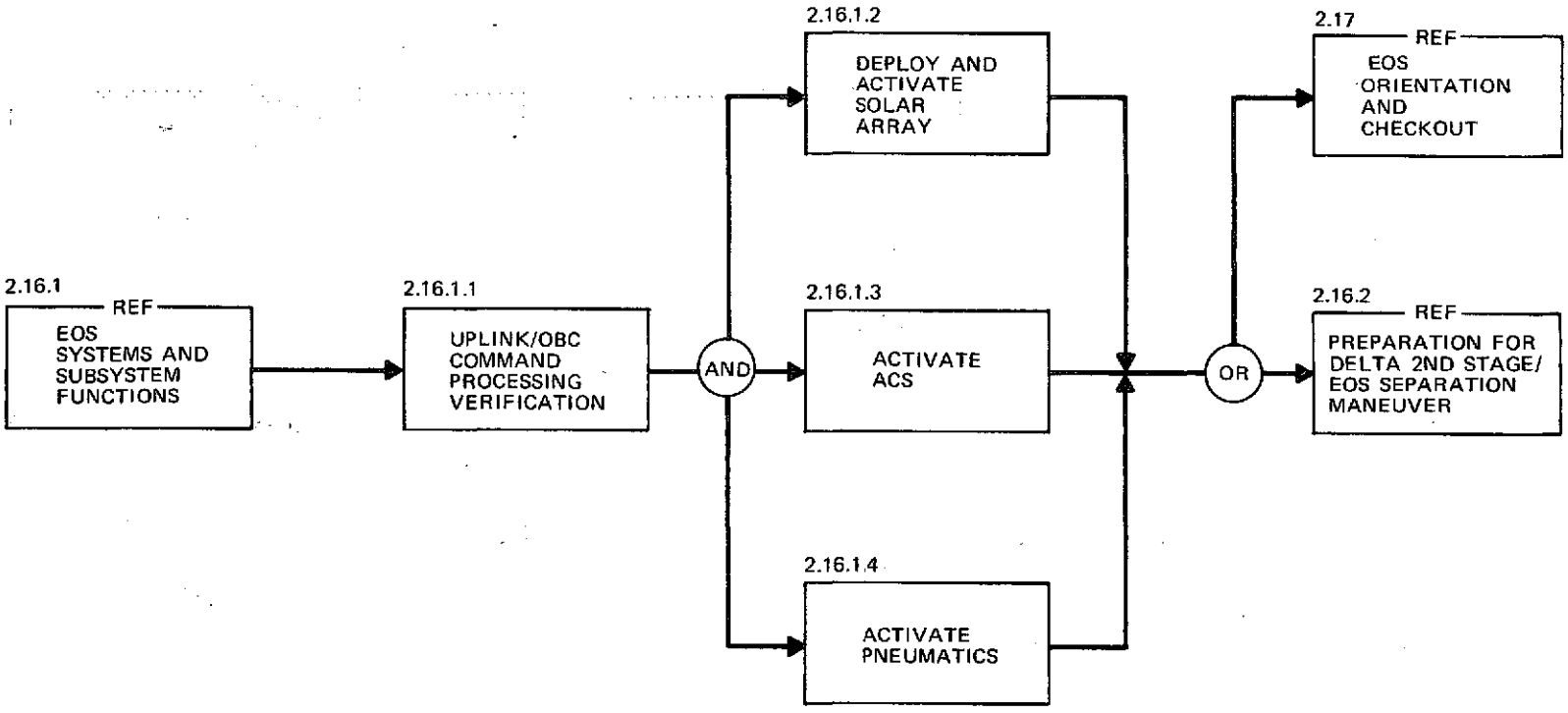


EOS Functional Analysis Level I

ORIGINAL PAGE IS
OF POOR QUALITY

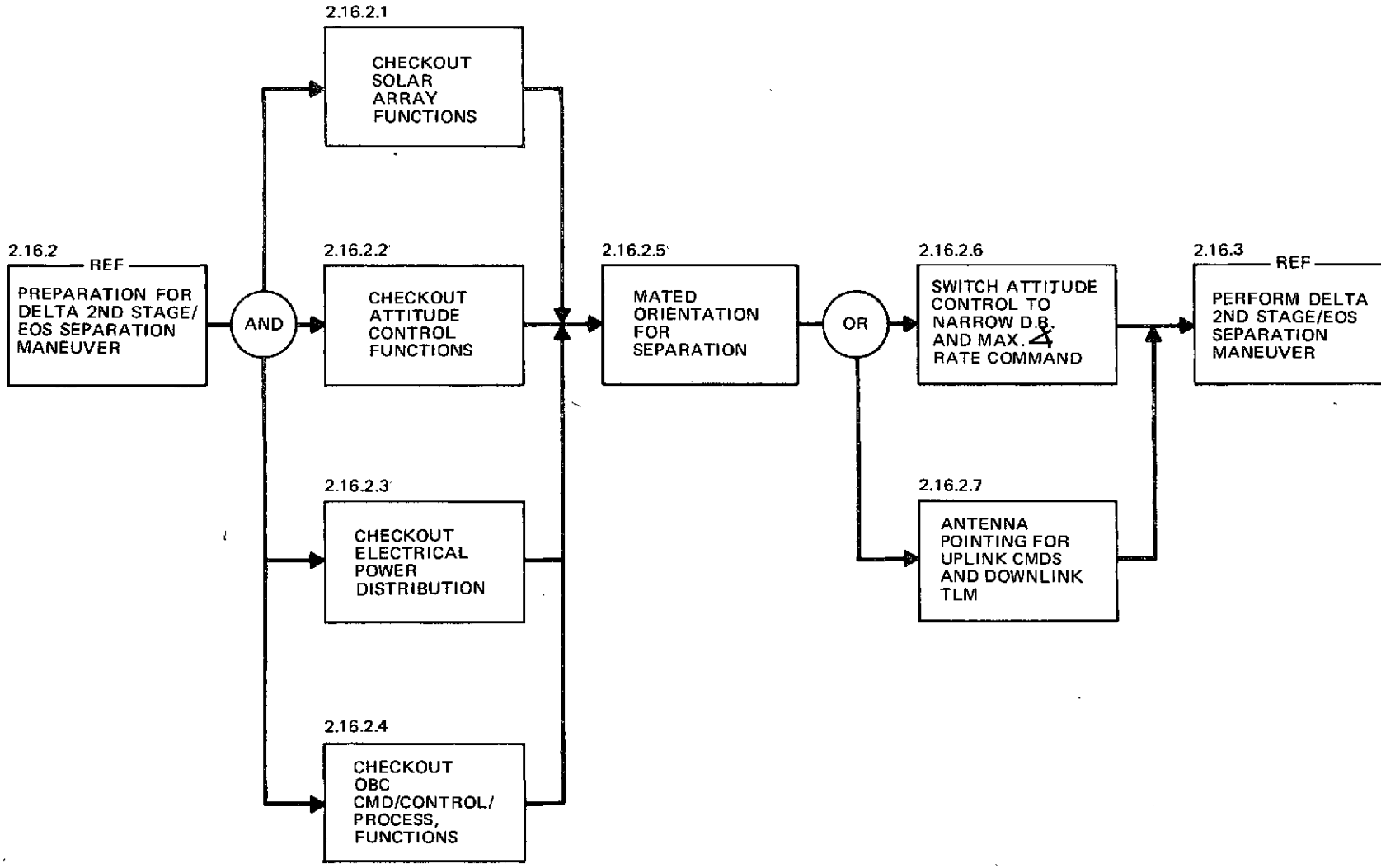


Level II–2.16 Post Orbit Insertion Operations

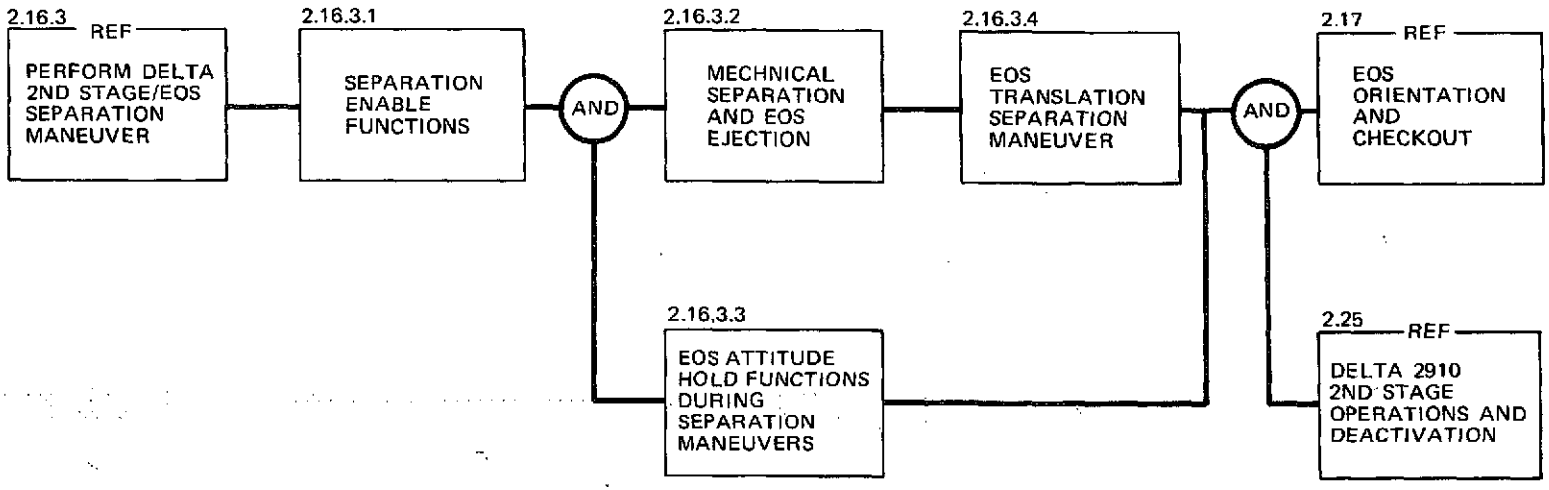


38-4

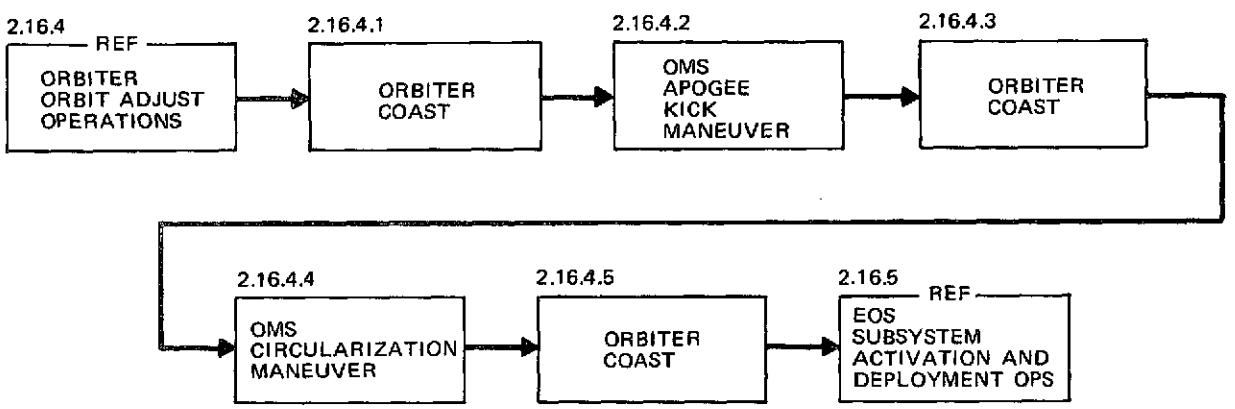
Level III—2.16.1 EOS System and Subsystem Functions



3B-5 **Level III–2.16.2 Preparation for Delta 2nd Stage/EOS Separation Maneuver**

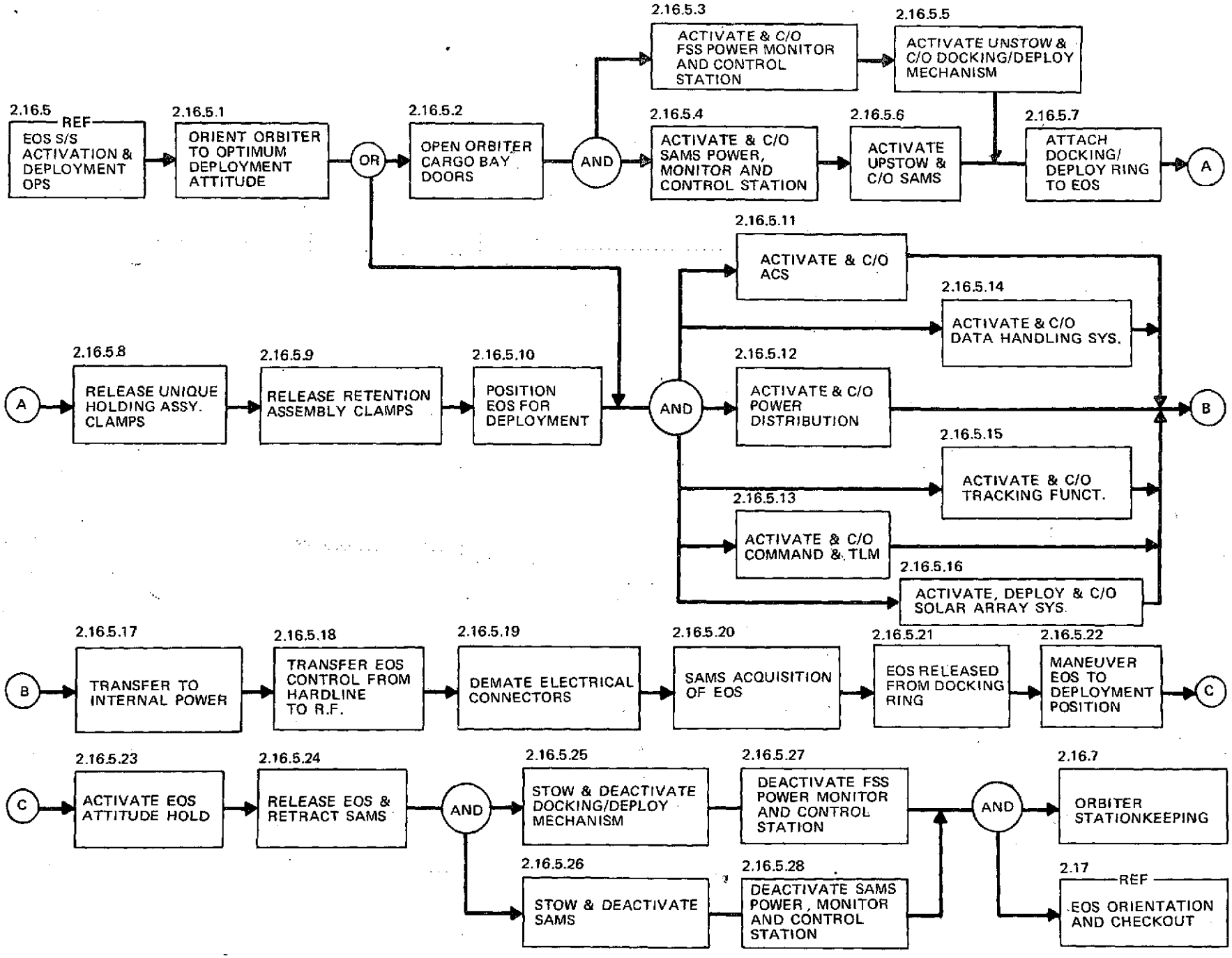


Level III–2.16.3 Perform Delta 2nd Stage/EOS Separation Maneuver

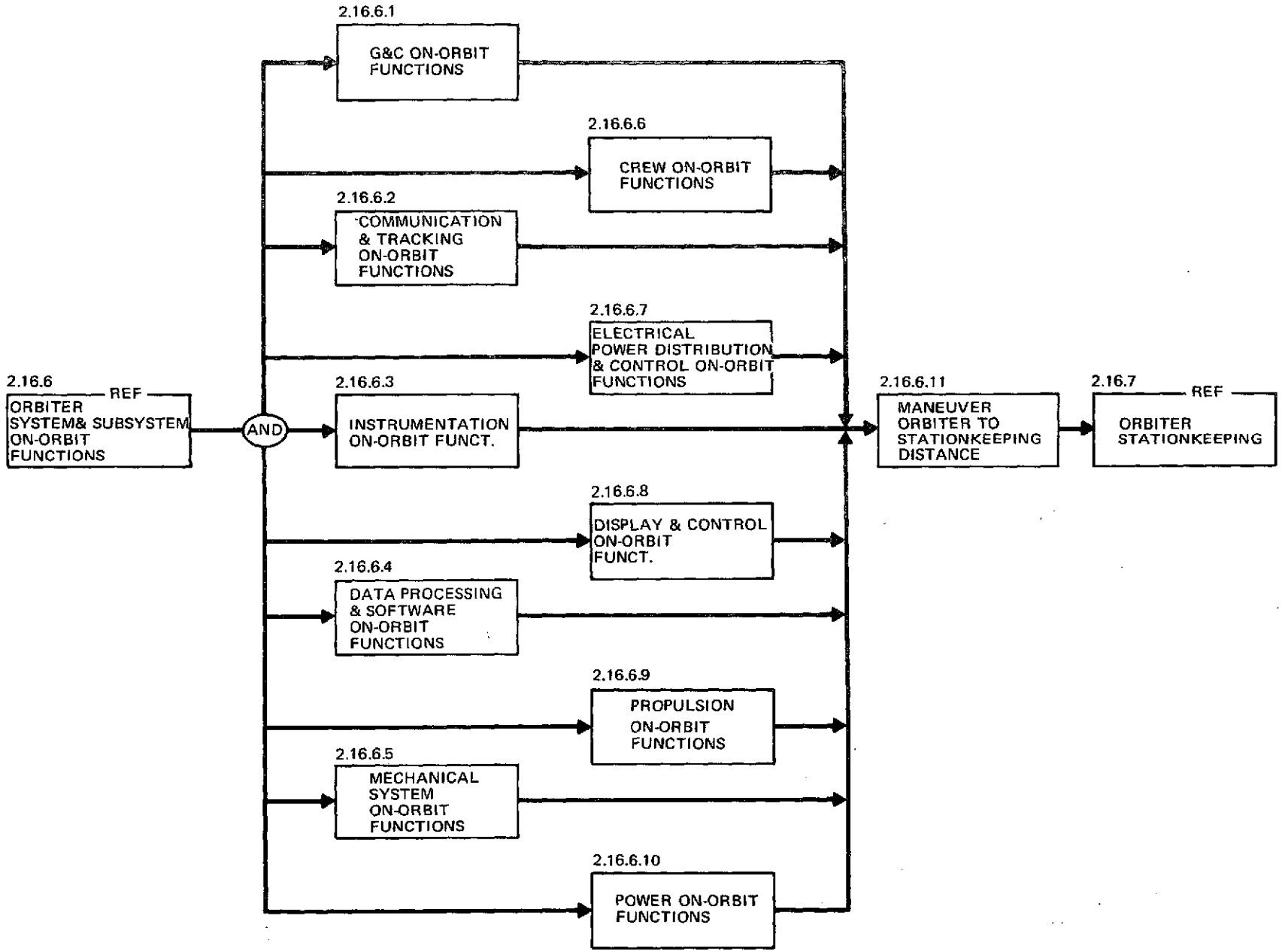


3B-7

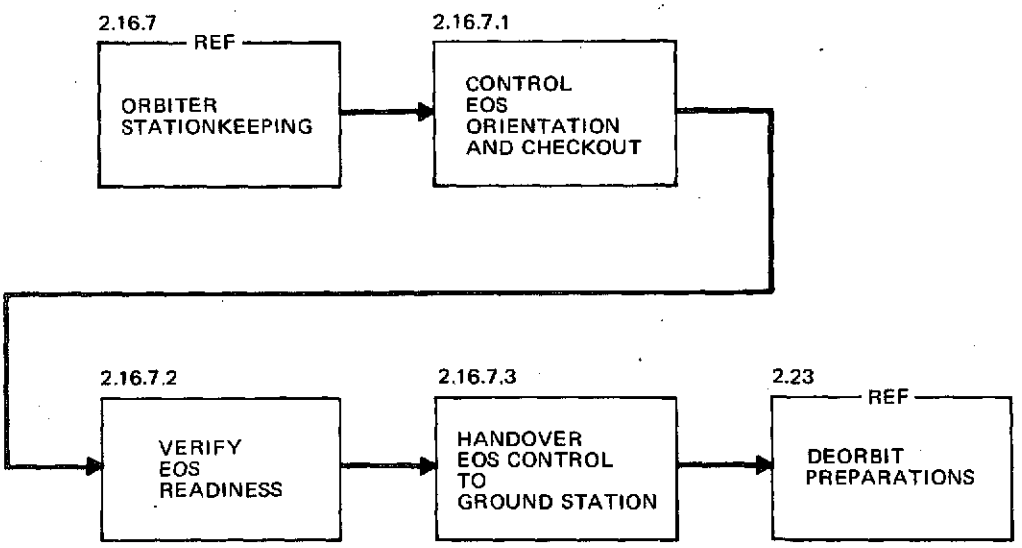
Level III—2.16.4 Orbiter Orbit Adjust Operations



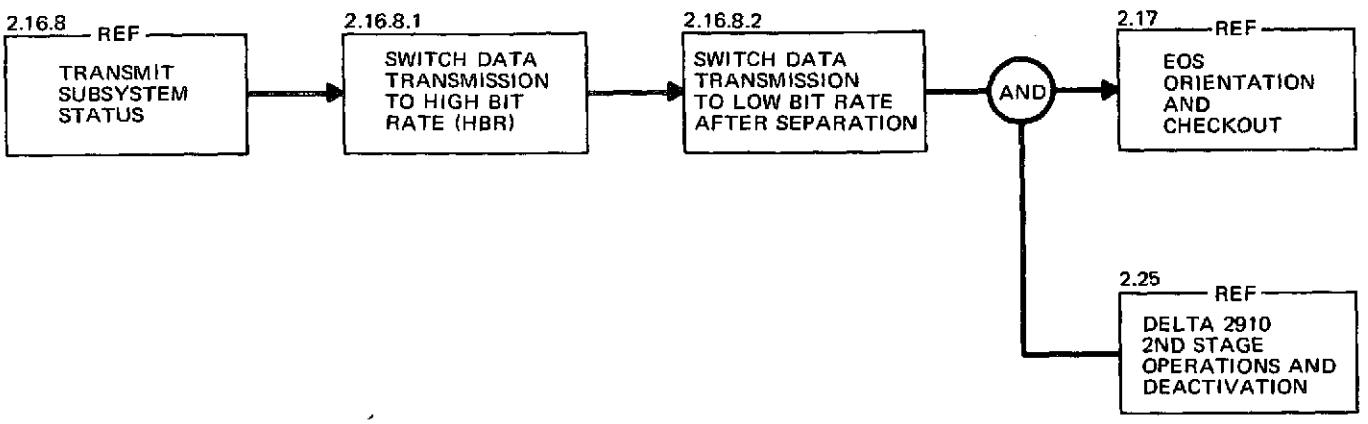
Level III—2.16.5 EOS Subsystem Activation and Deployment Operation



Level III–2.16.6 Orbiter System and Subsystem On-Orbit Function

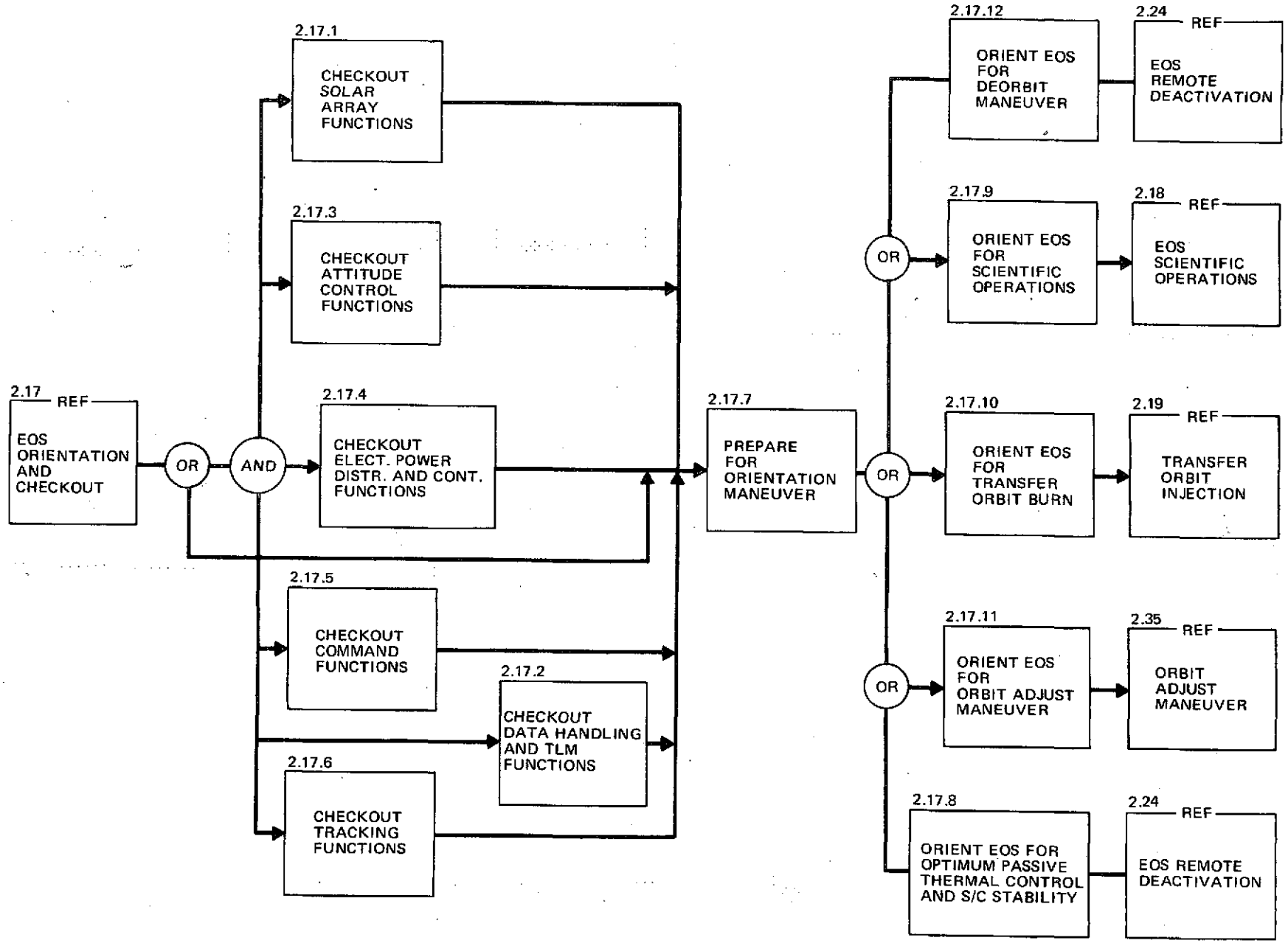


3B-10 **Level III—2.16.7 Orbiter Stationkeeping**

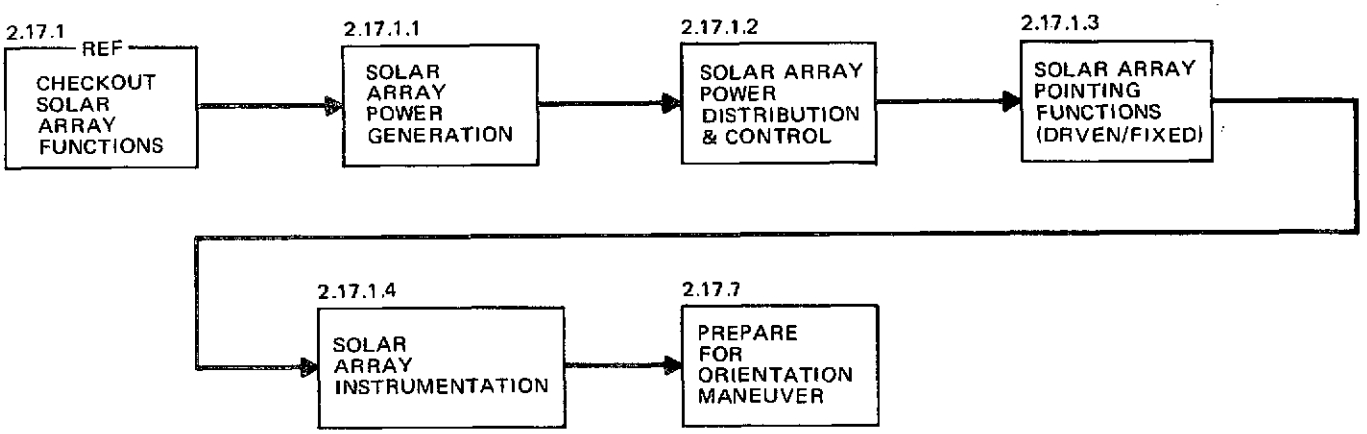


3B-11

Level III–2.16.8 Transmit Subsystem Status

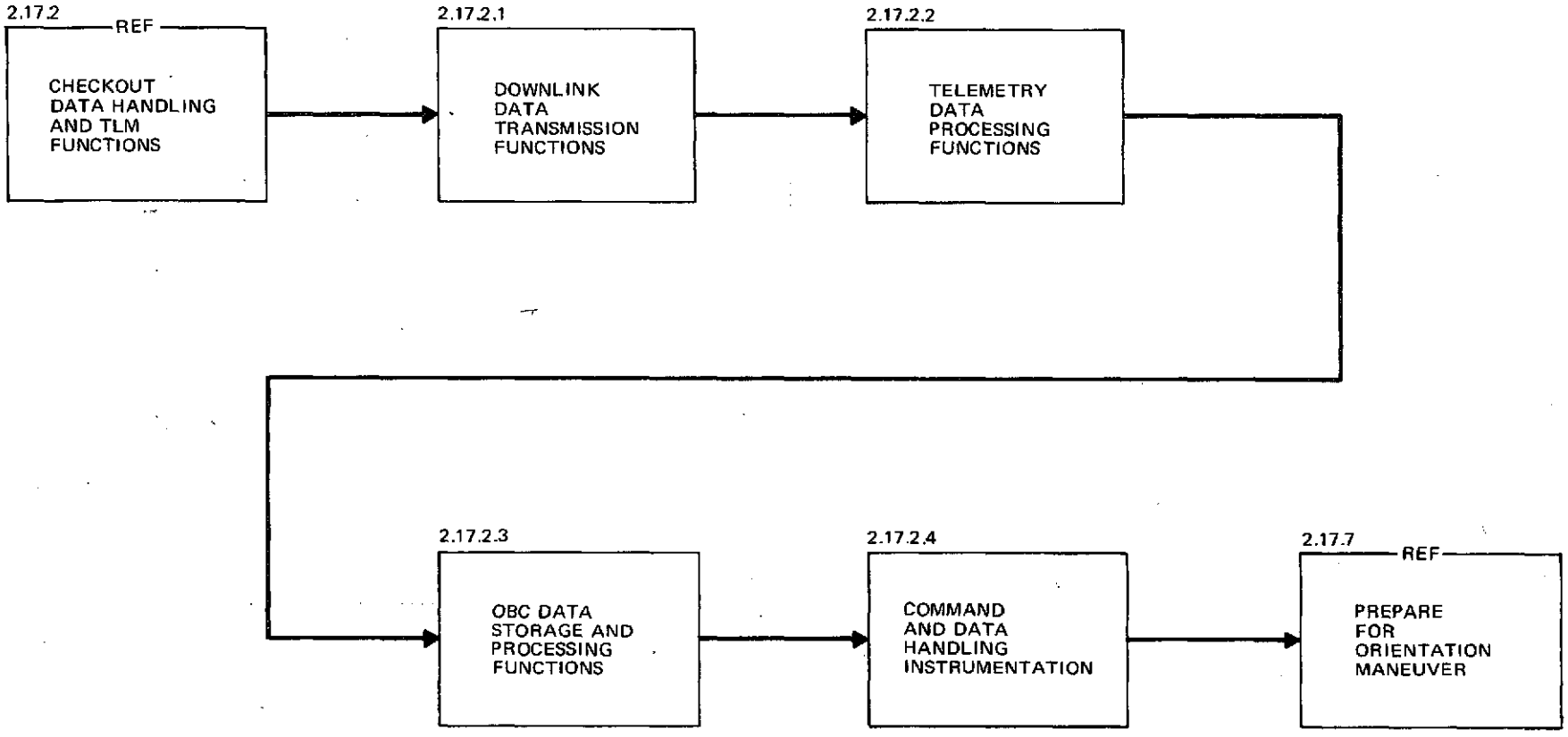


Level II—2.17 EOS Orientation and Checkout



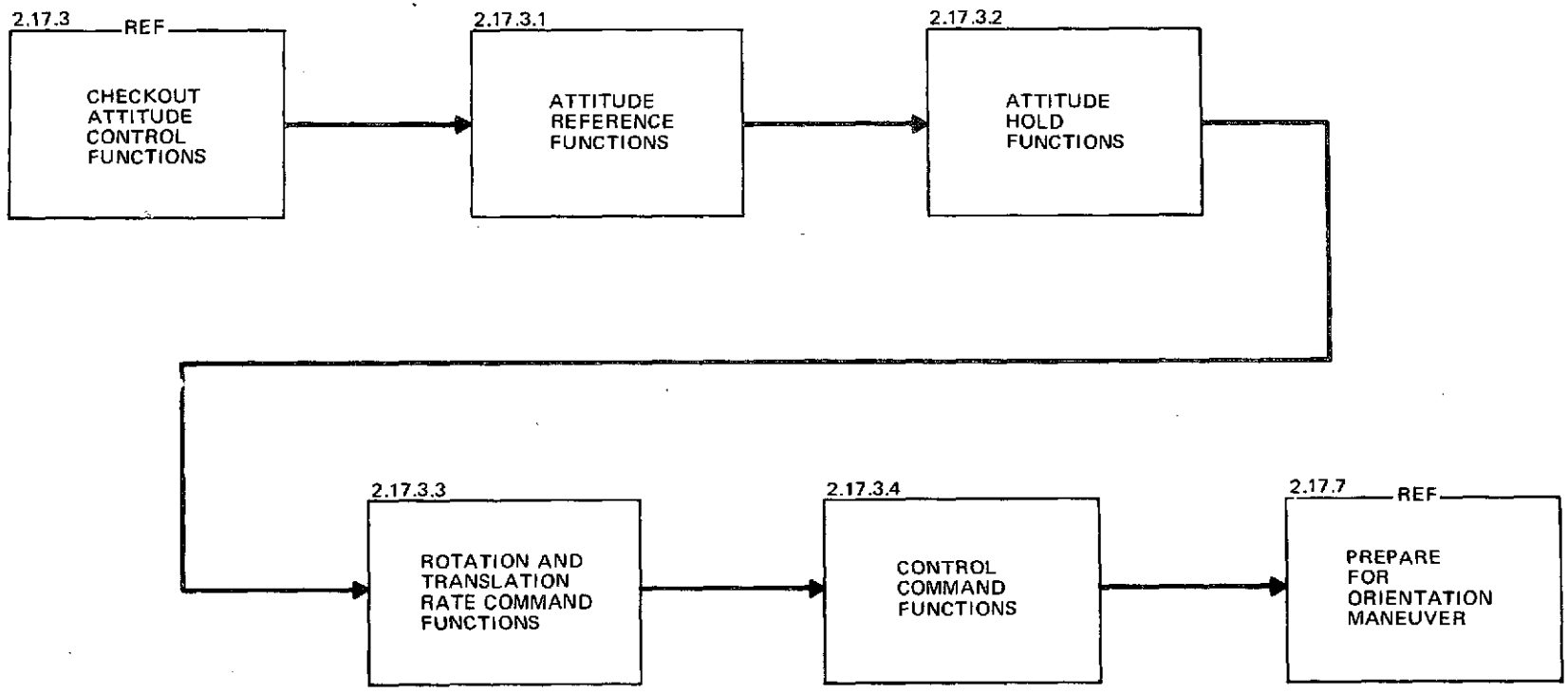
3B-13

Level III–2.17.1 Checkout Solar Array Functions

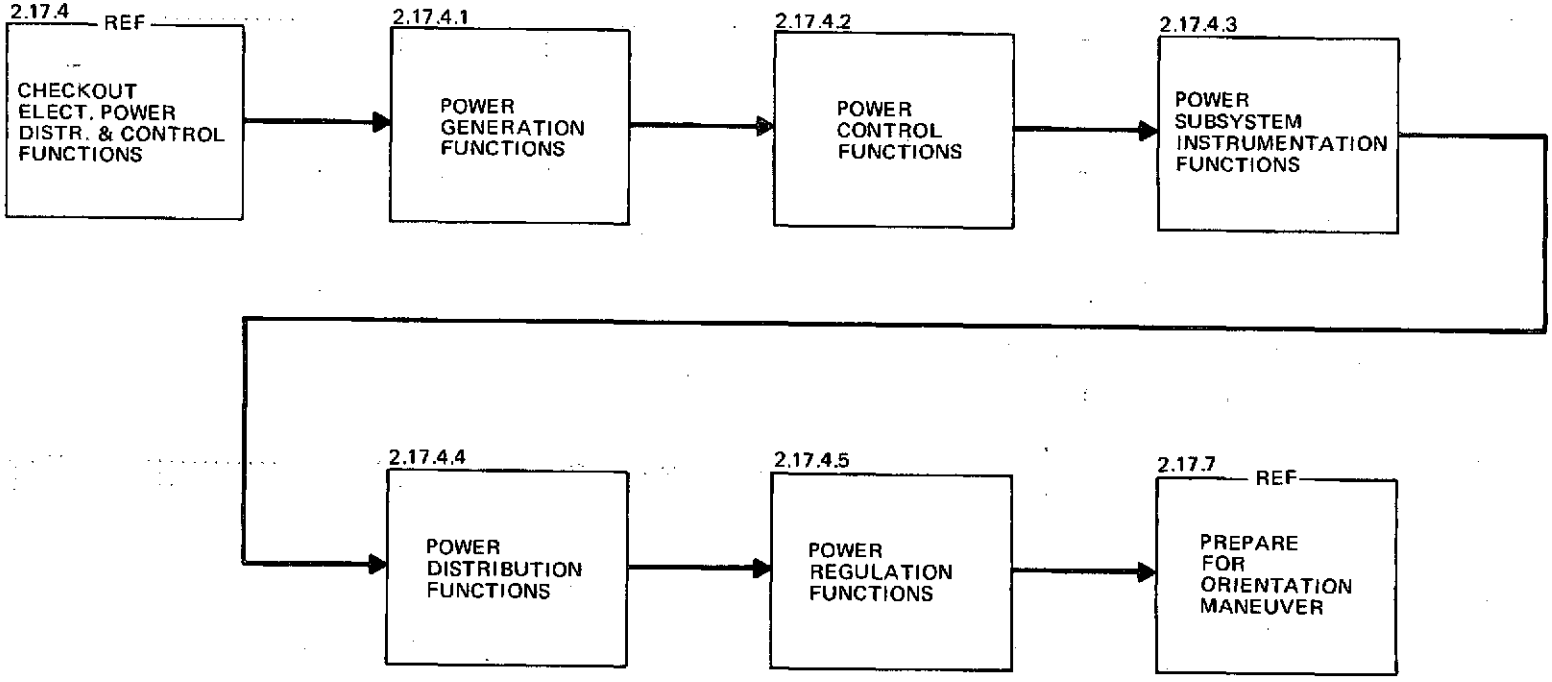


38-14

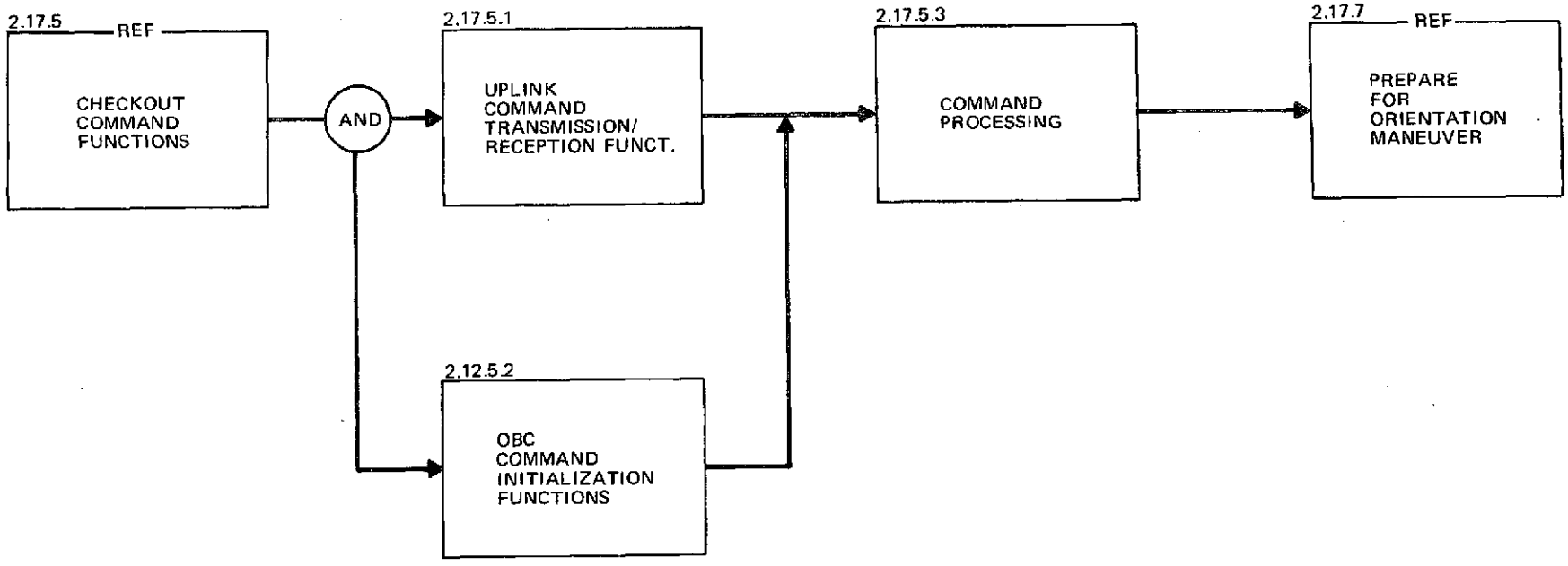
Level III–2.17.2 Checkout Data Handling and Telemetry Functions



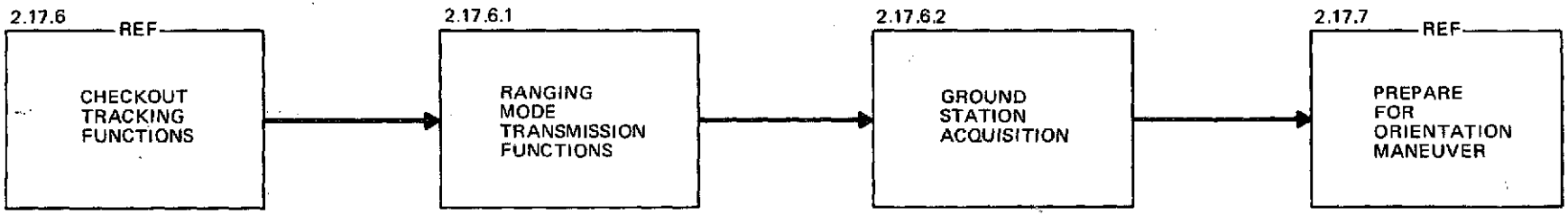
Level III--2.17.3 Checkout Attitude Control Functions



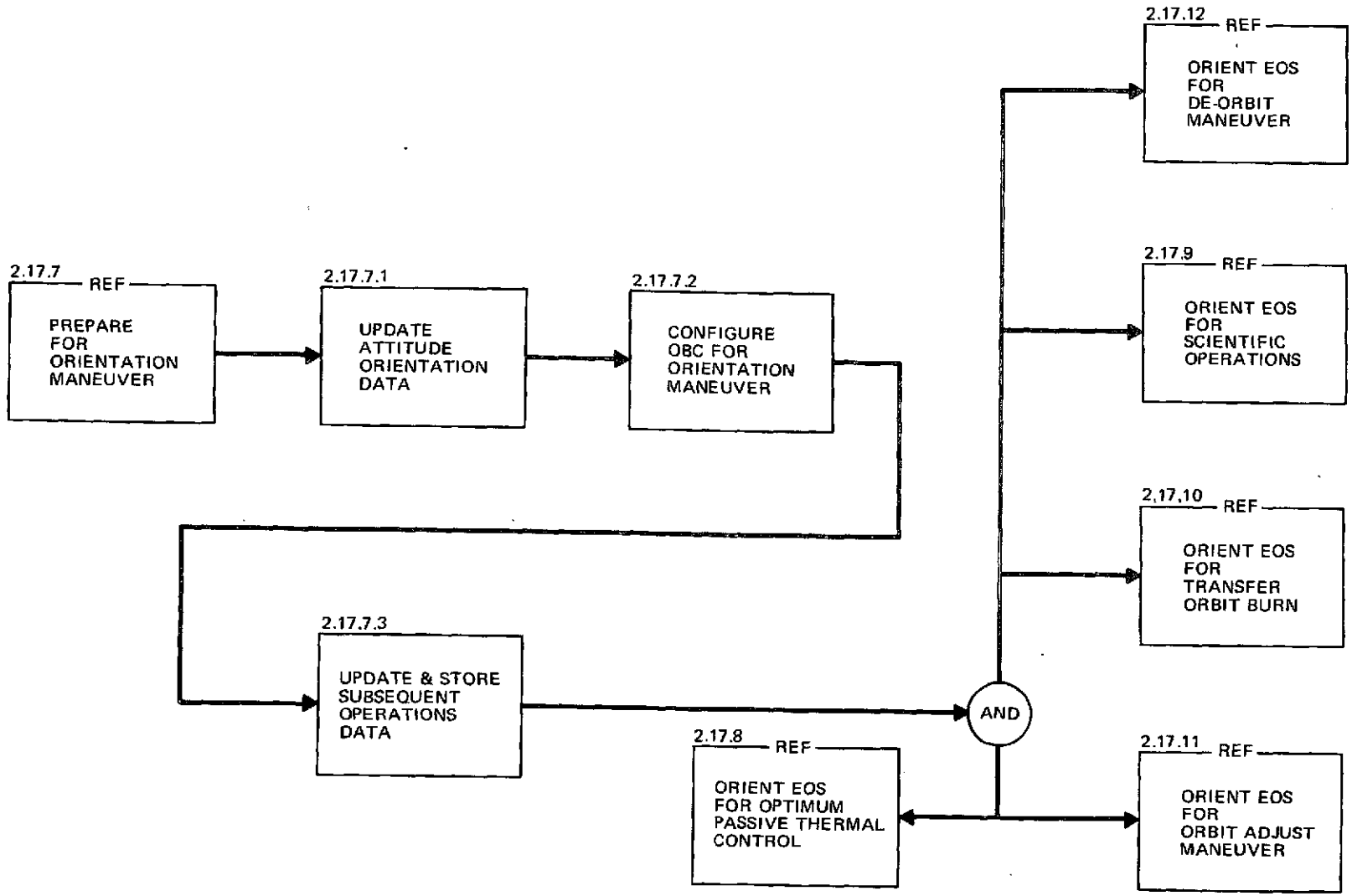
Level III–2.17.4 Checkout Electrical Power Distribution and Control Functions



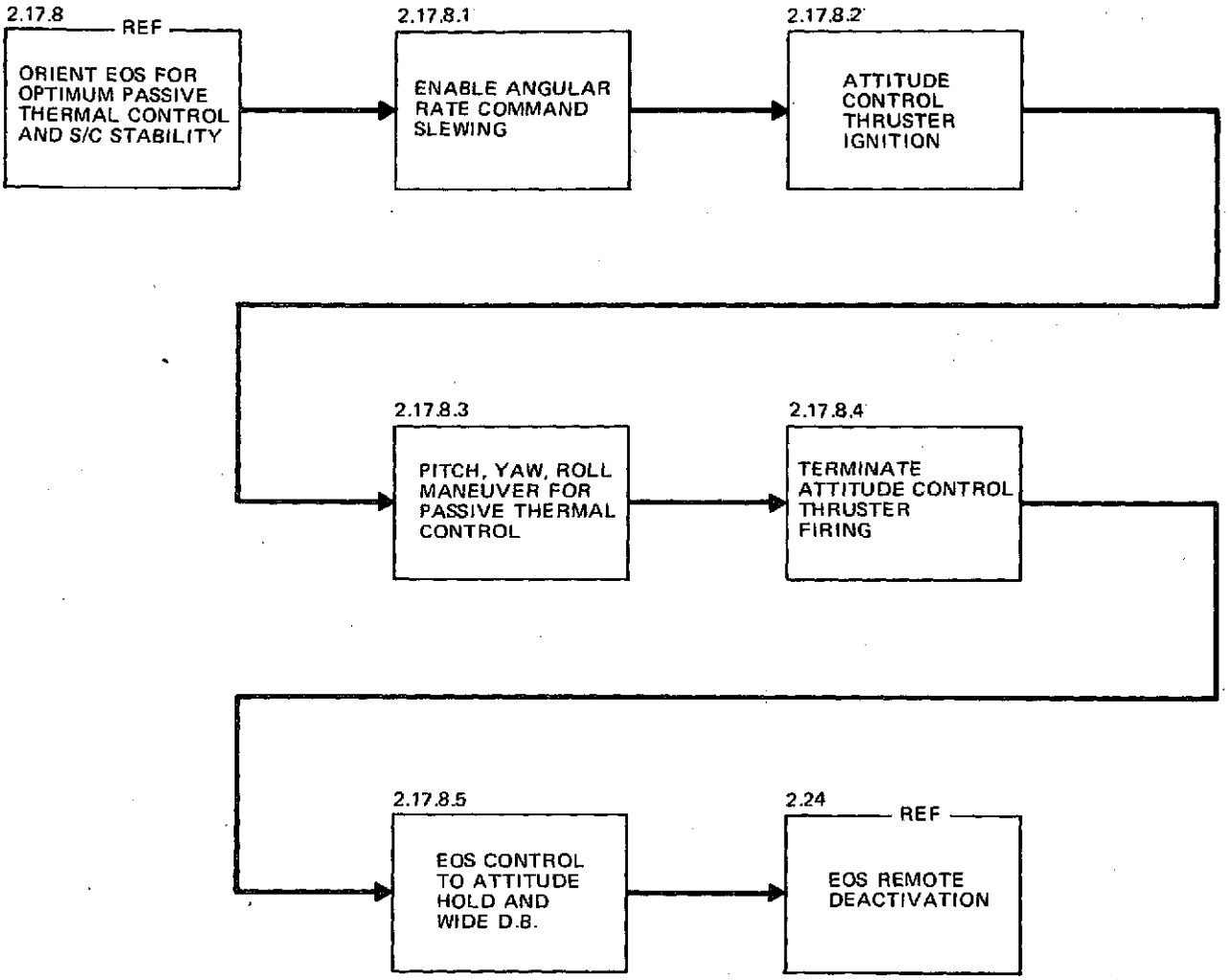
Level III—2.17.5 Checkout Command Functions



Level III–2.17.6 Checkout Tracking Functions

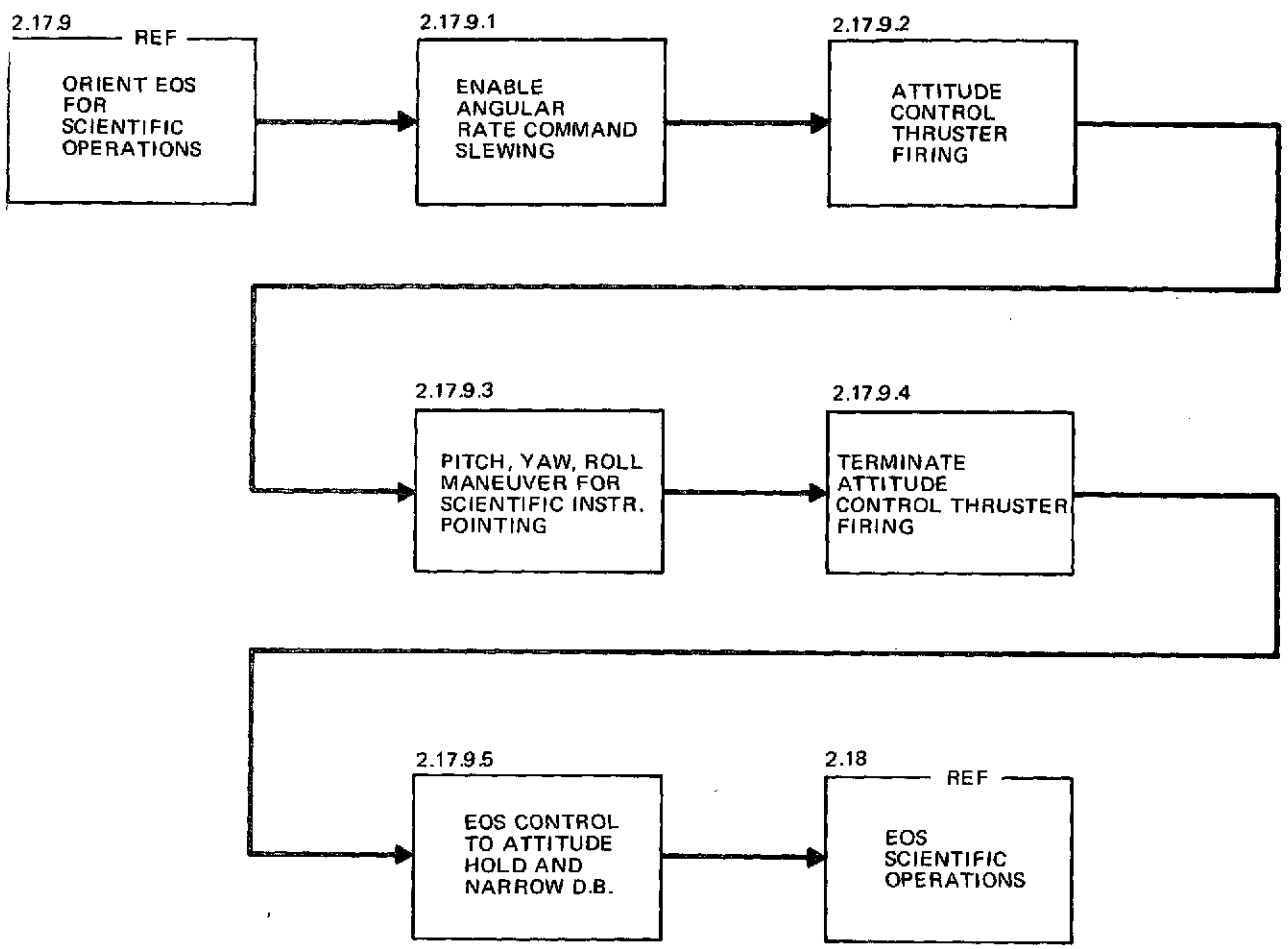


Level III—2.17.7 Prepare for Orientation Maneuver



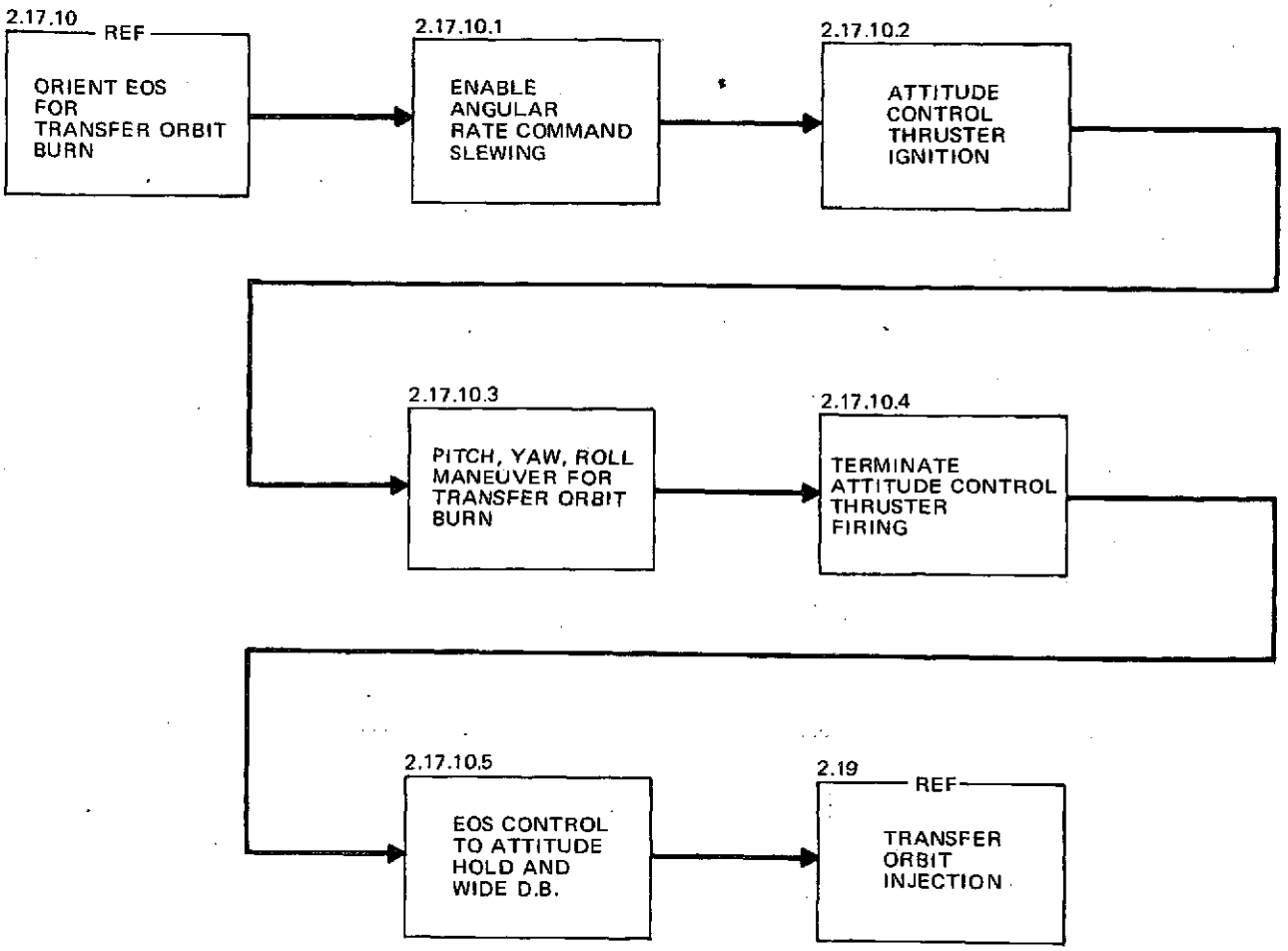
3B-20

Level III–2.17.8 Orient EOS for Optimum Passive Thermal Control and S/C Stability



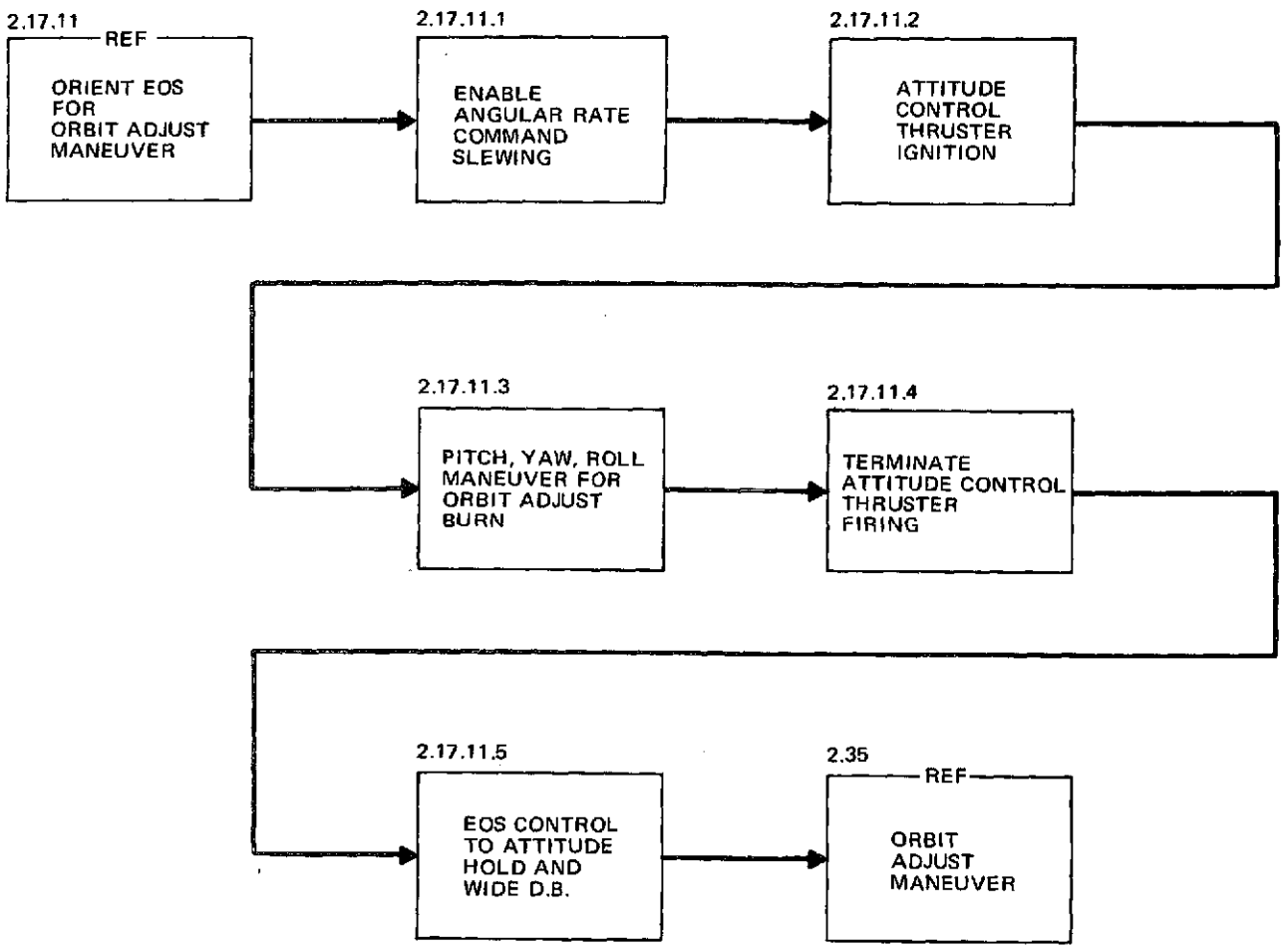
3B-21

Level III—2.17.9 Orient EOS for Scientific Operations



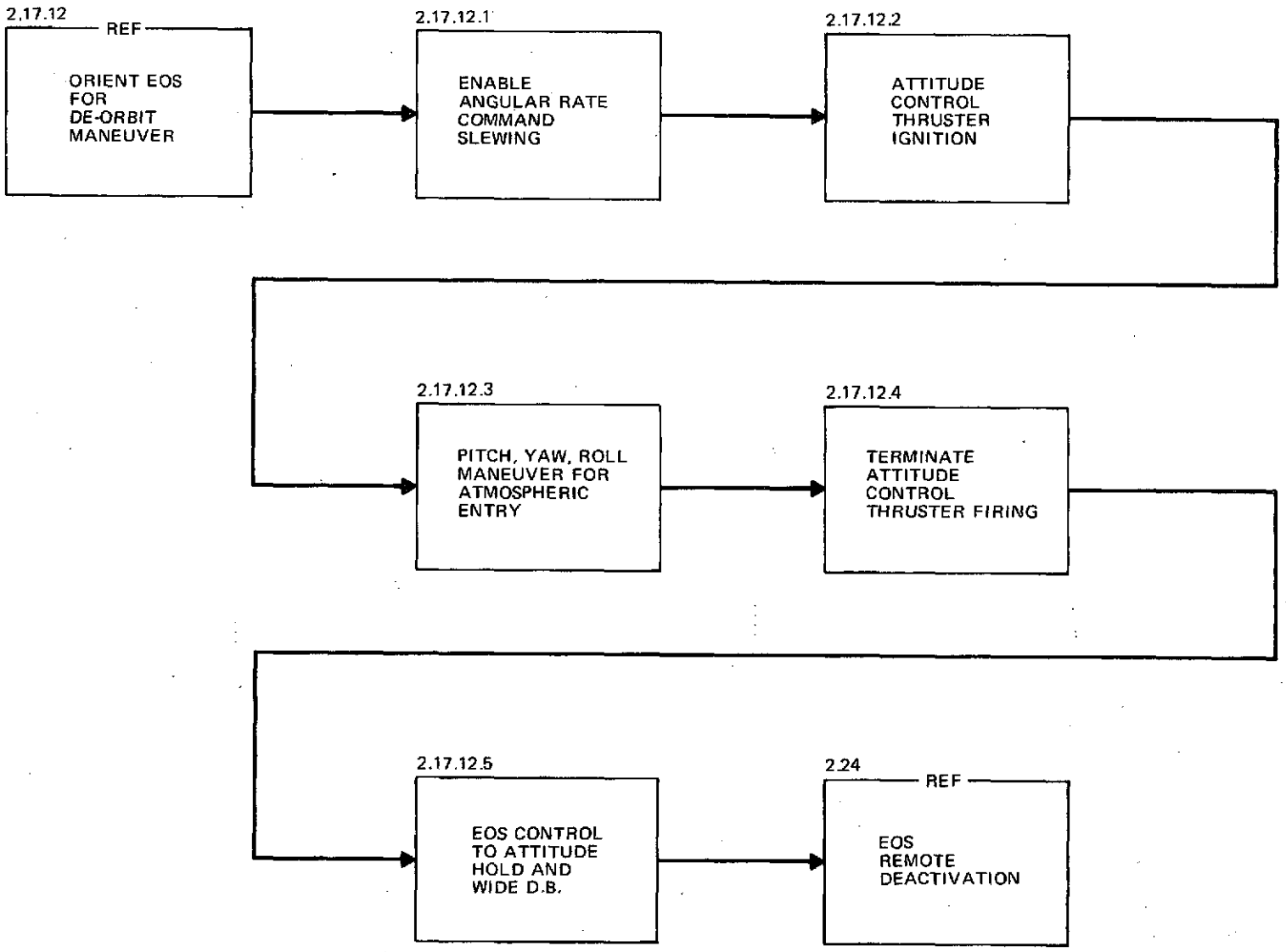
38-22

Level III–2.17.10 Orient EOS for Transfer Orbit Burn



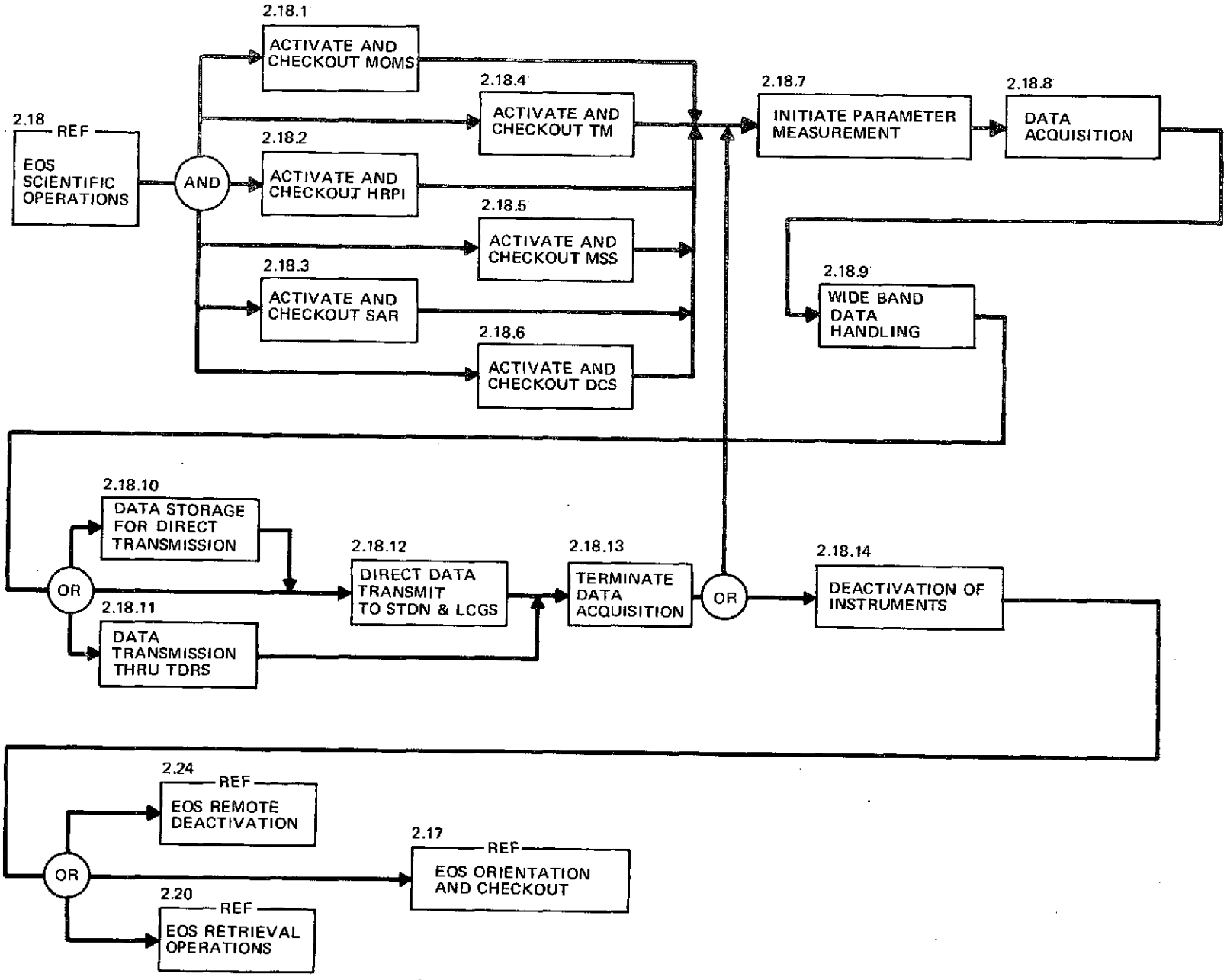
3B-23

Level III—2.17.11 Orient EOS for Orbit Adjust Maneuver

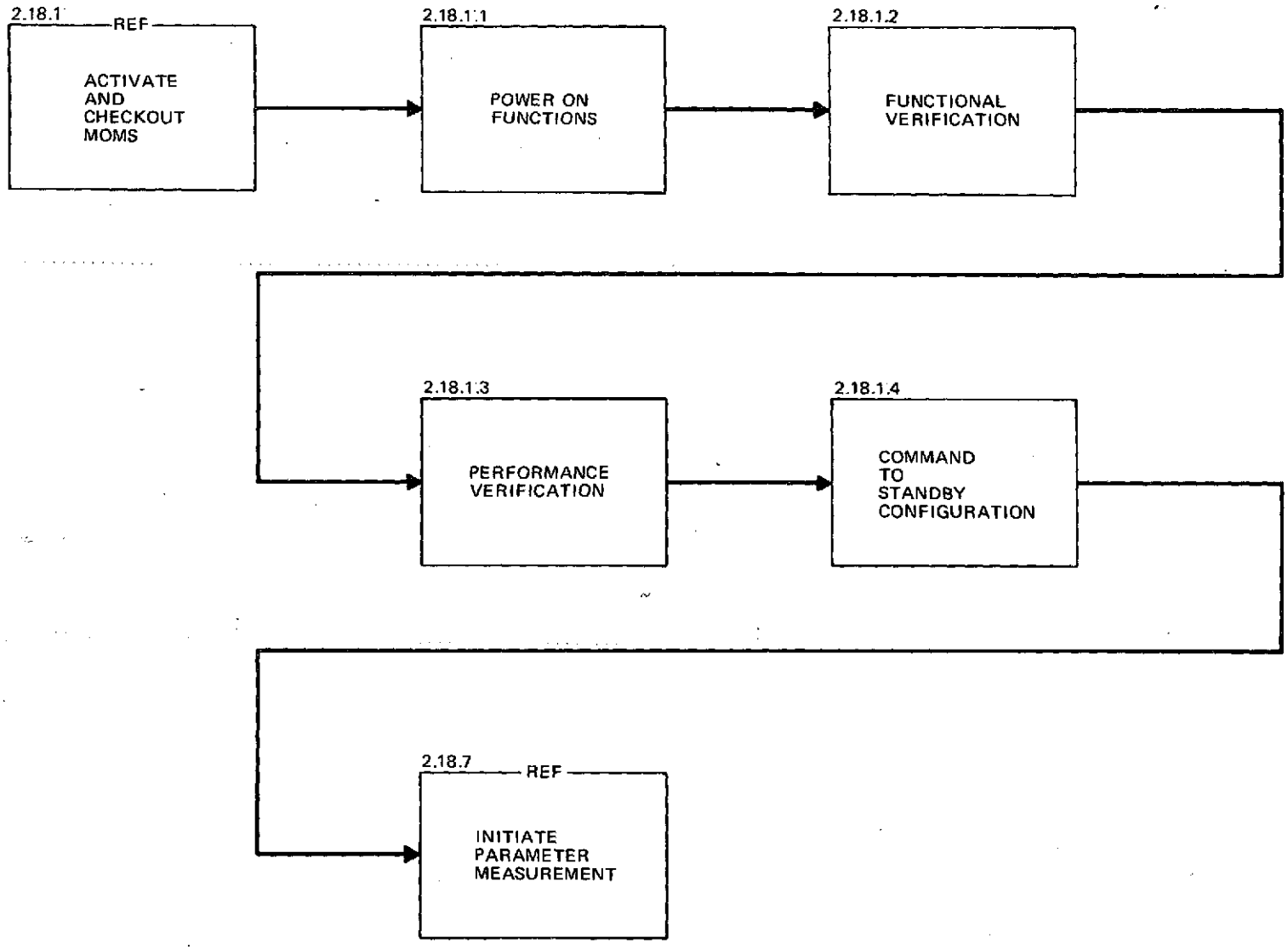


3B-24

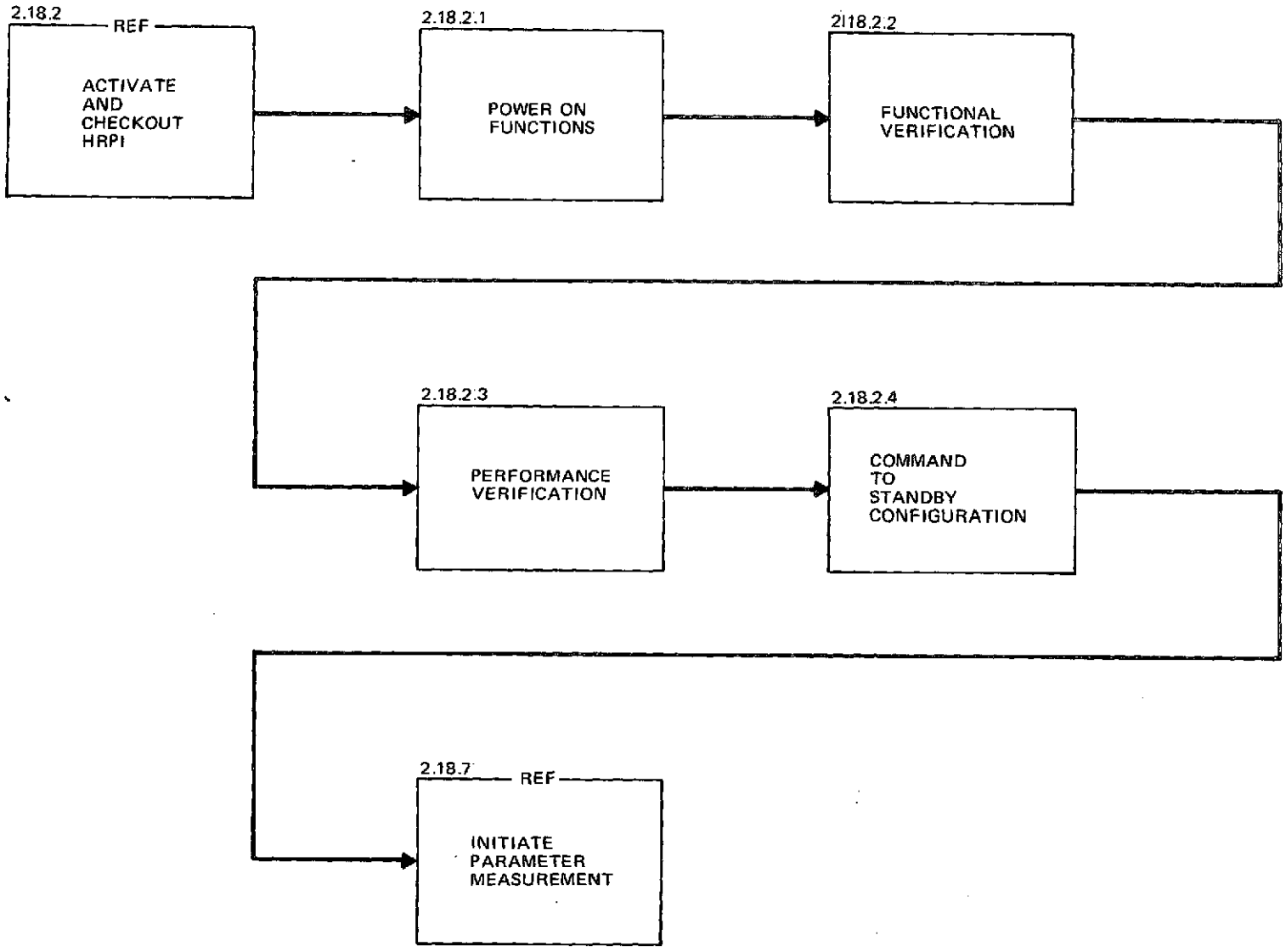
Level III–2.17.12 Orient EOS for De-Orbit Maneuver



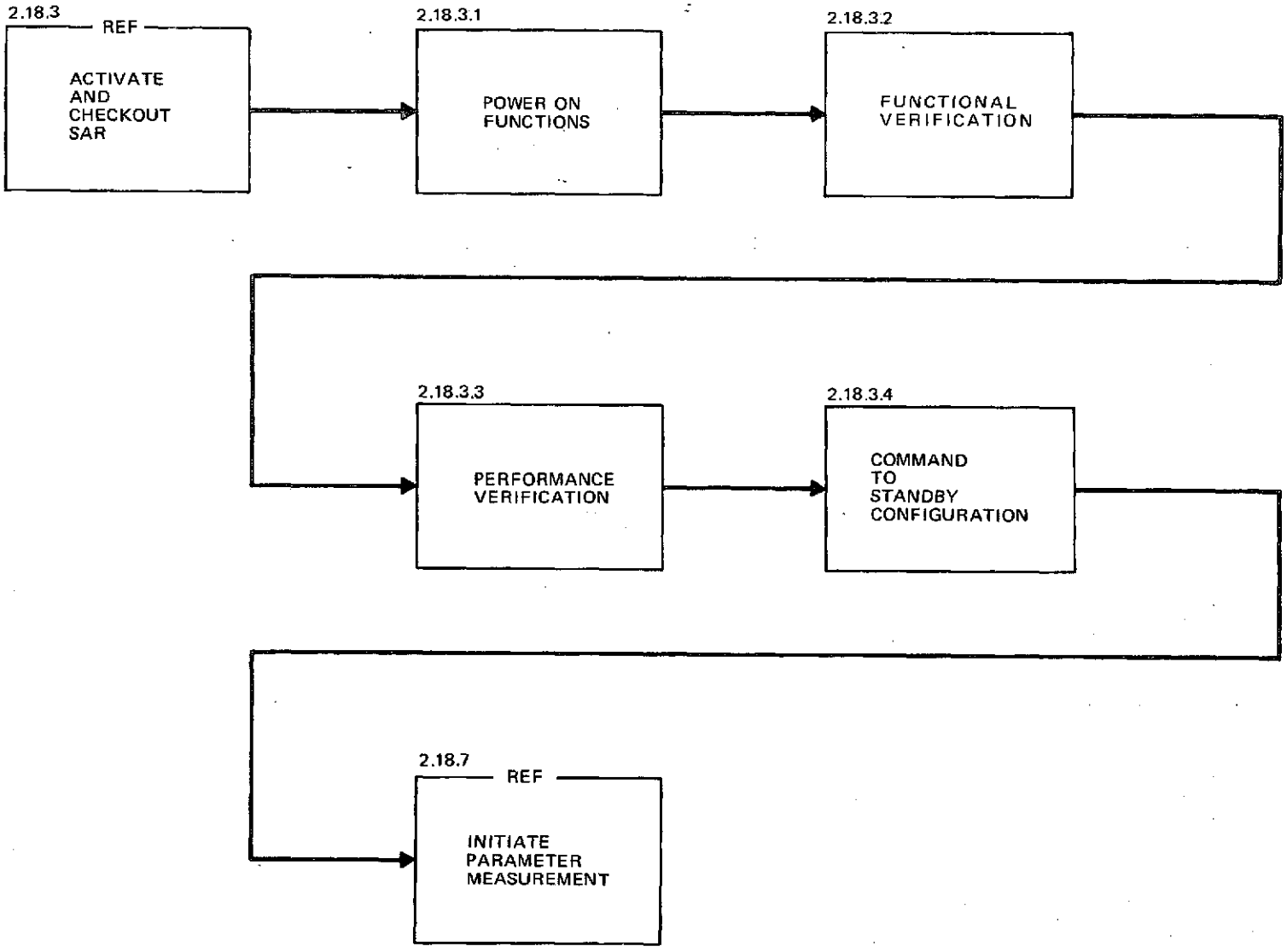
Level II–2.18 EOS Scientific Operations



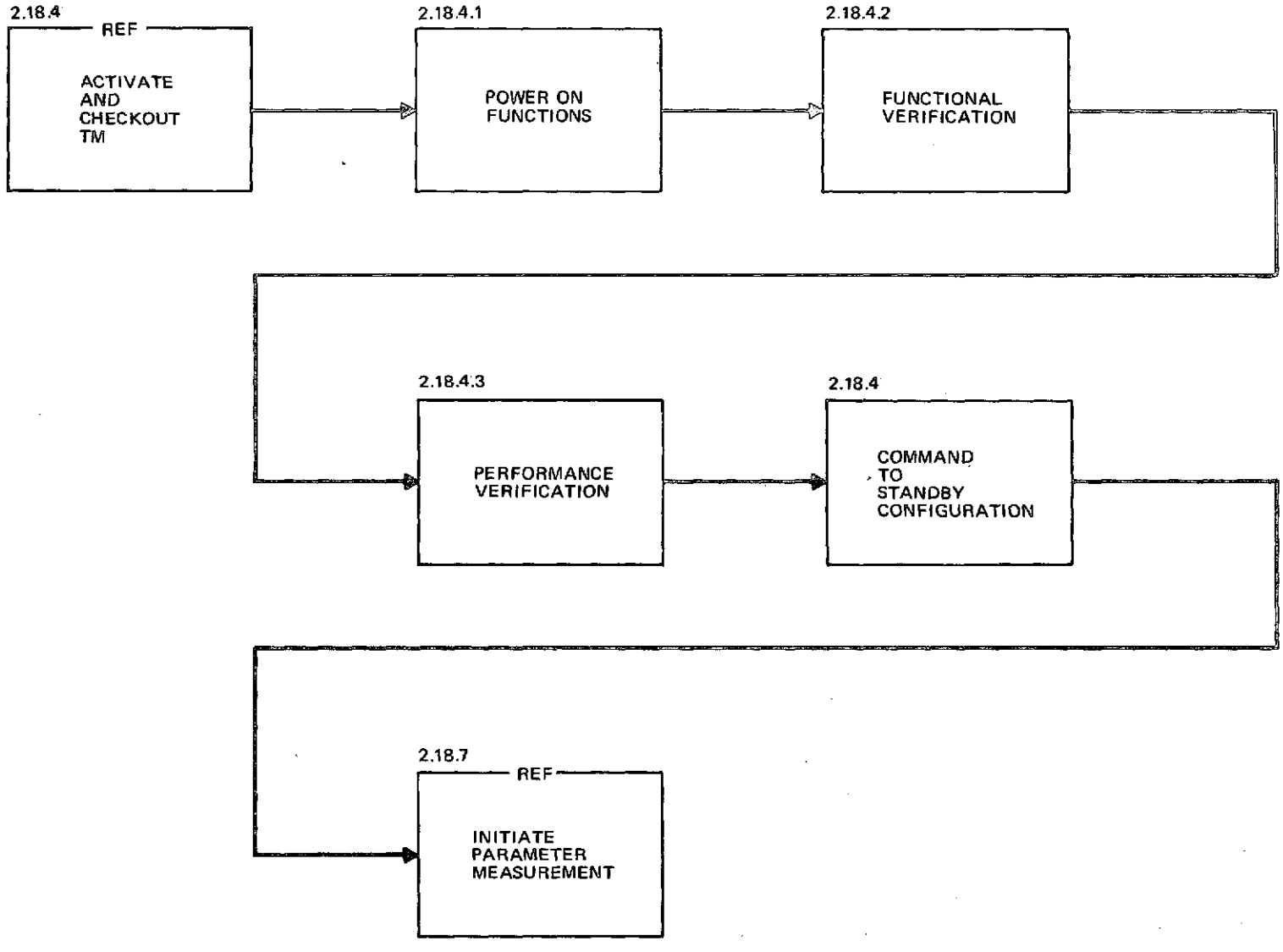
Level III–2.18.1 Activate and Checkout MOMS



Level III–2.18.2 Activate and Checkout HRPI

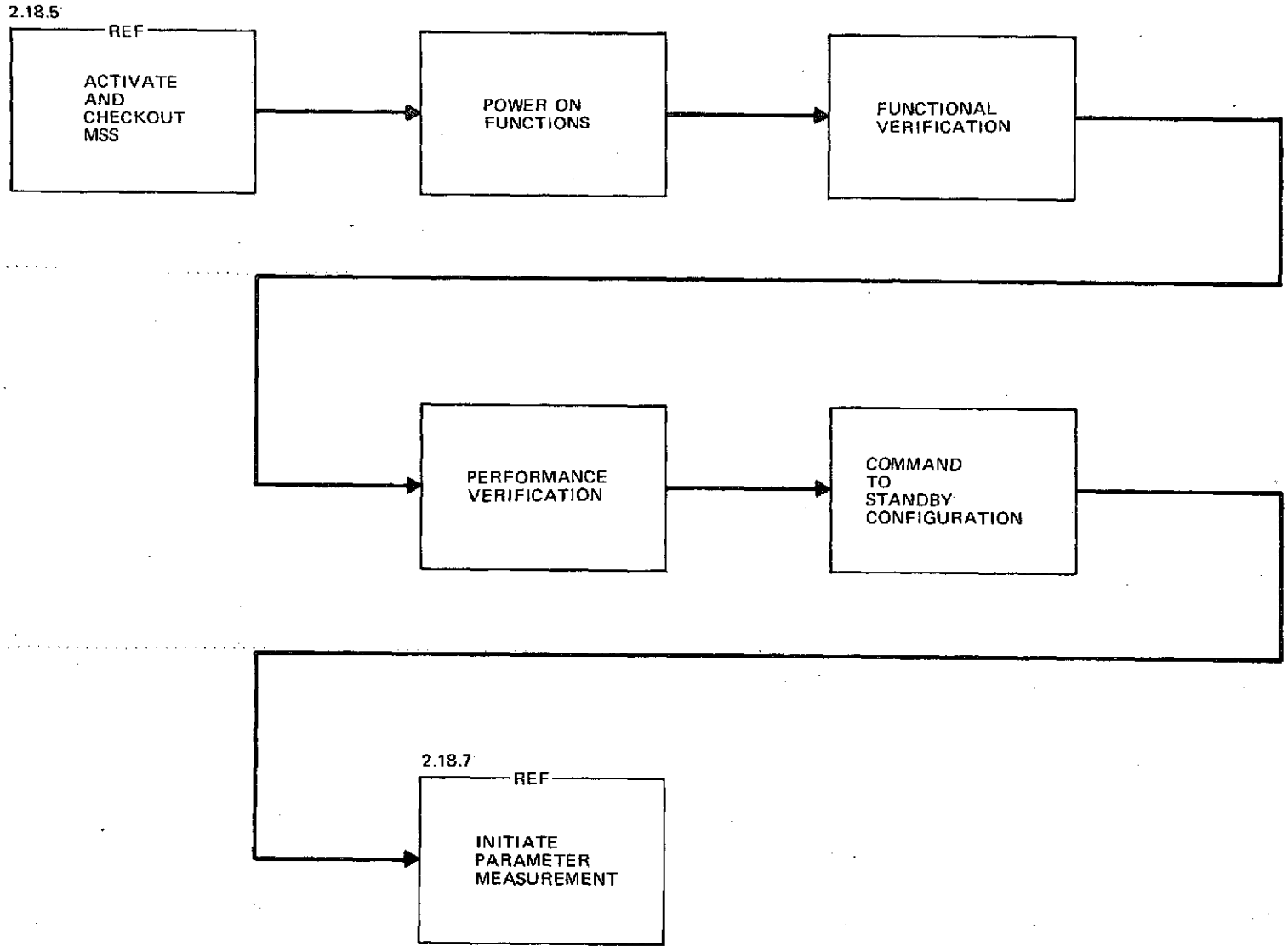


Level III–2.18.3 Activate and Checkout SAR

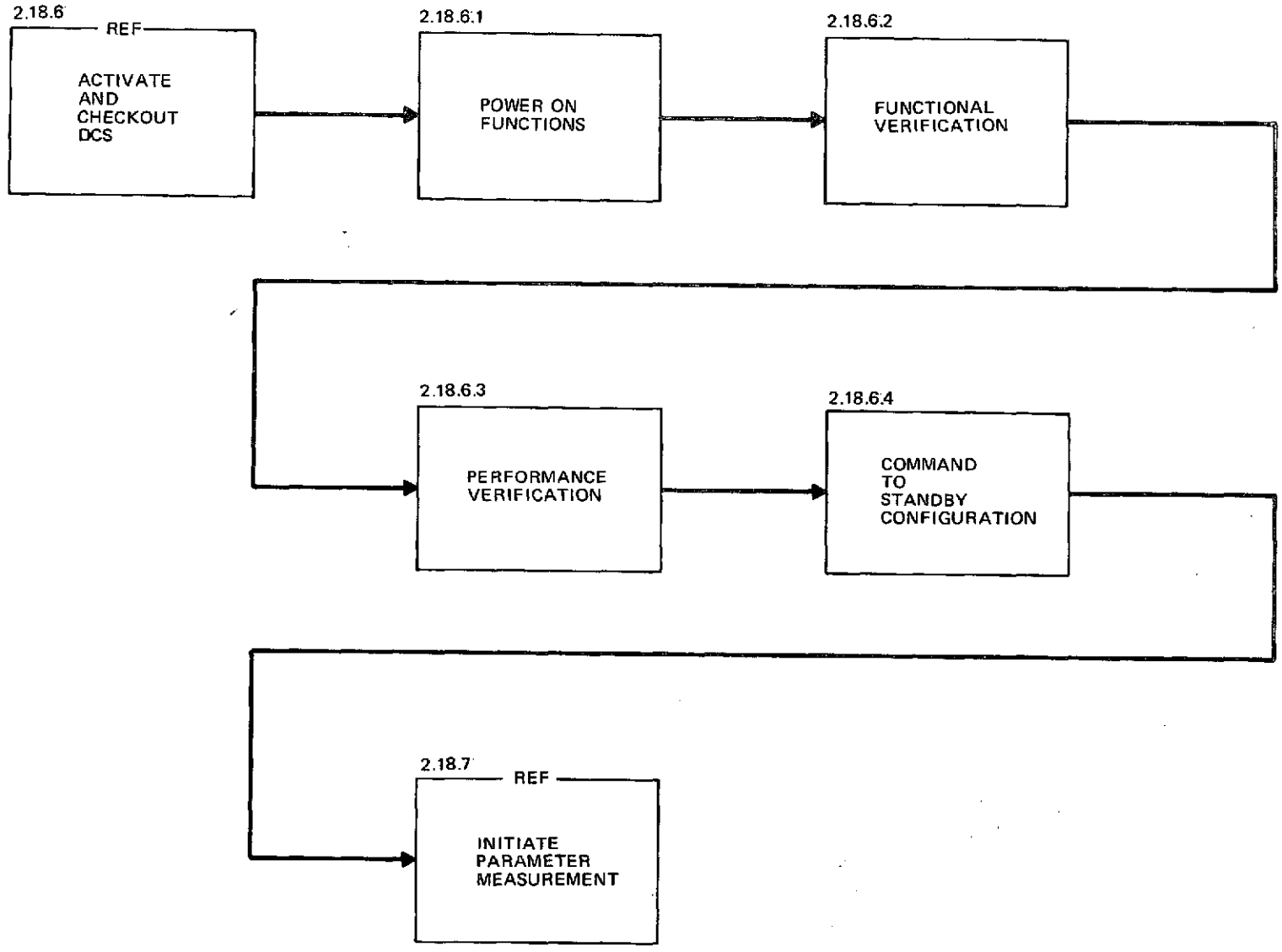


38-29

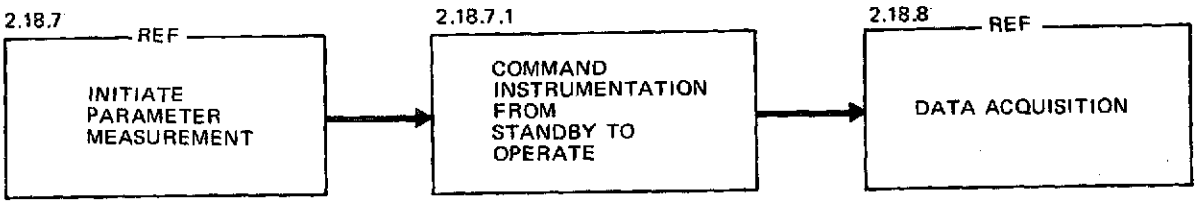
Level III–2.18.4 Activate and Checkout TM



Level III–2.18.5 Activate and Checkout MSS

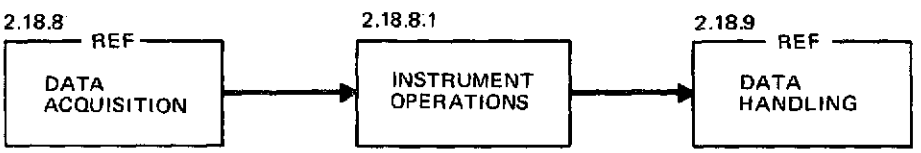


Level III–2.18.6 Activate and Checkout DCS



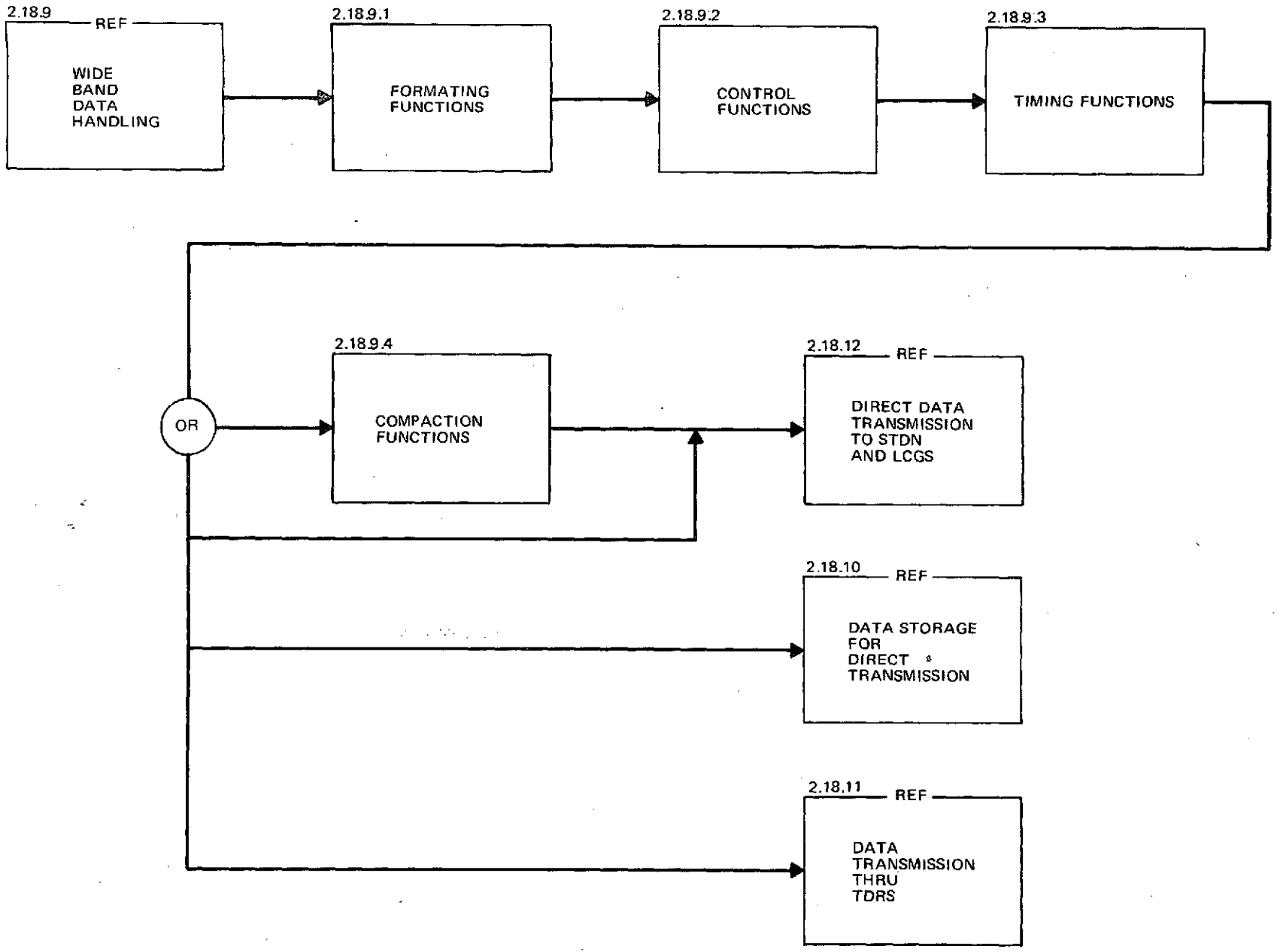
3B-32

Level III—2.18.7 Initiate Parameter Measurement

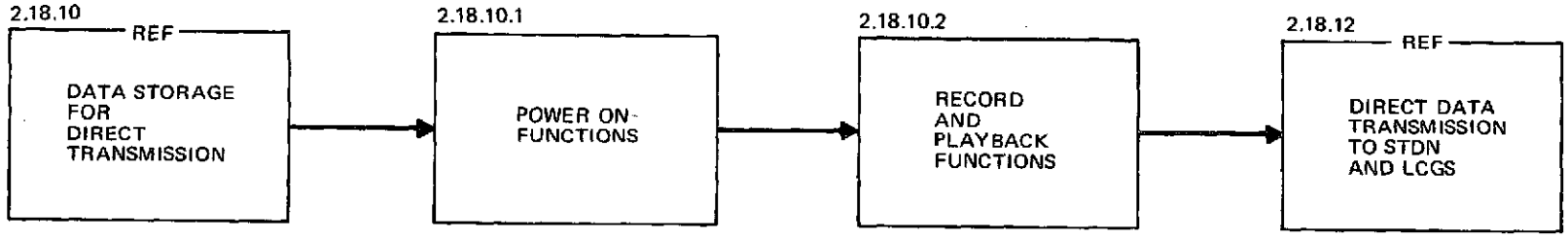


3B-33

Level III–2.18.8 Data Acquisition

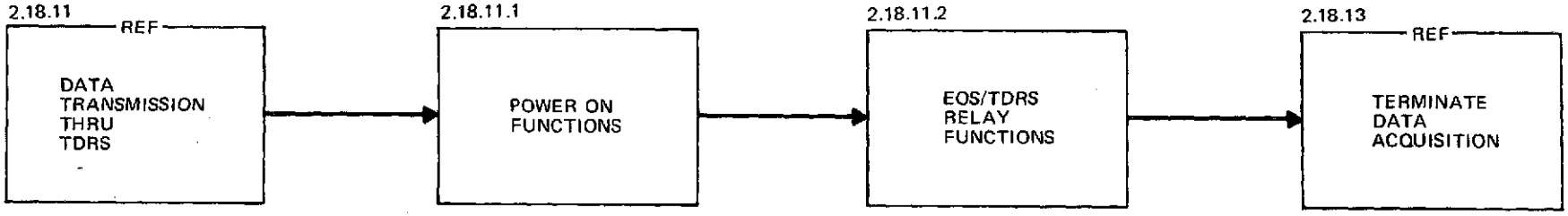


Level III –2.18.9 Wide Band Data Handling

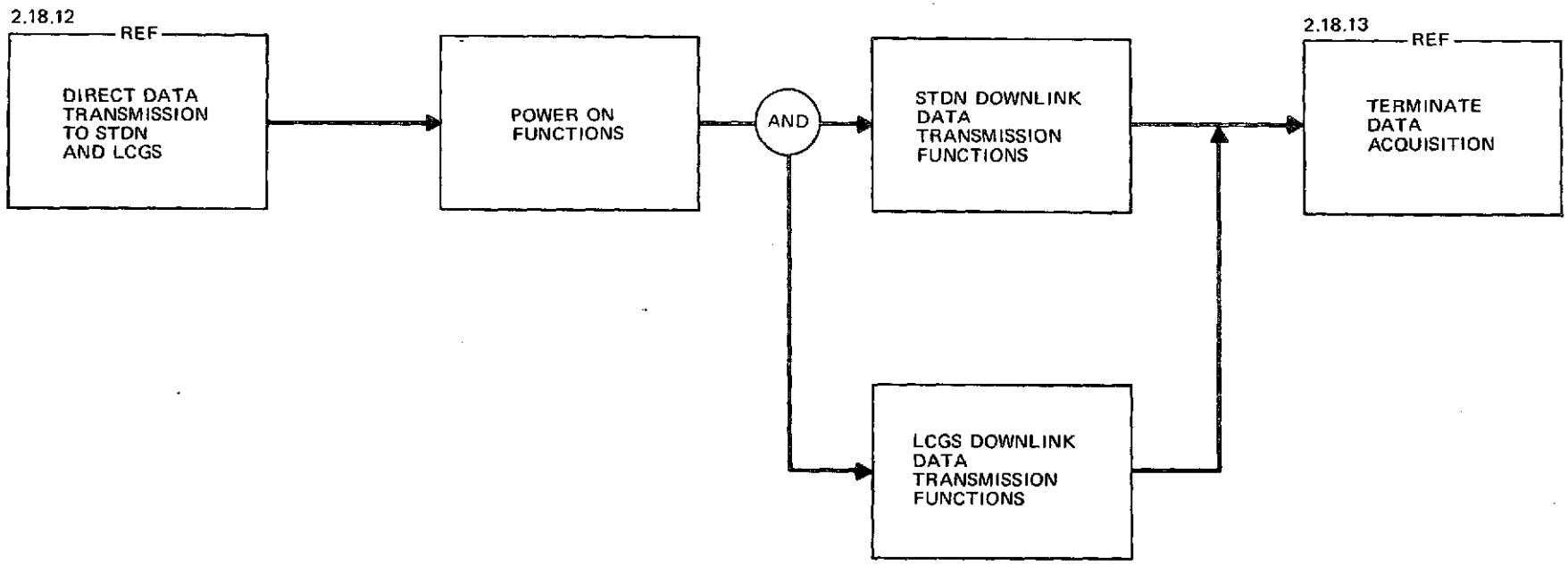


38-35

Level III–2.18.10 Data Storage for Direct Transmission

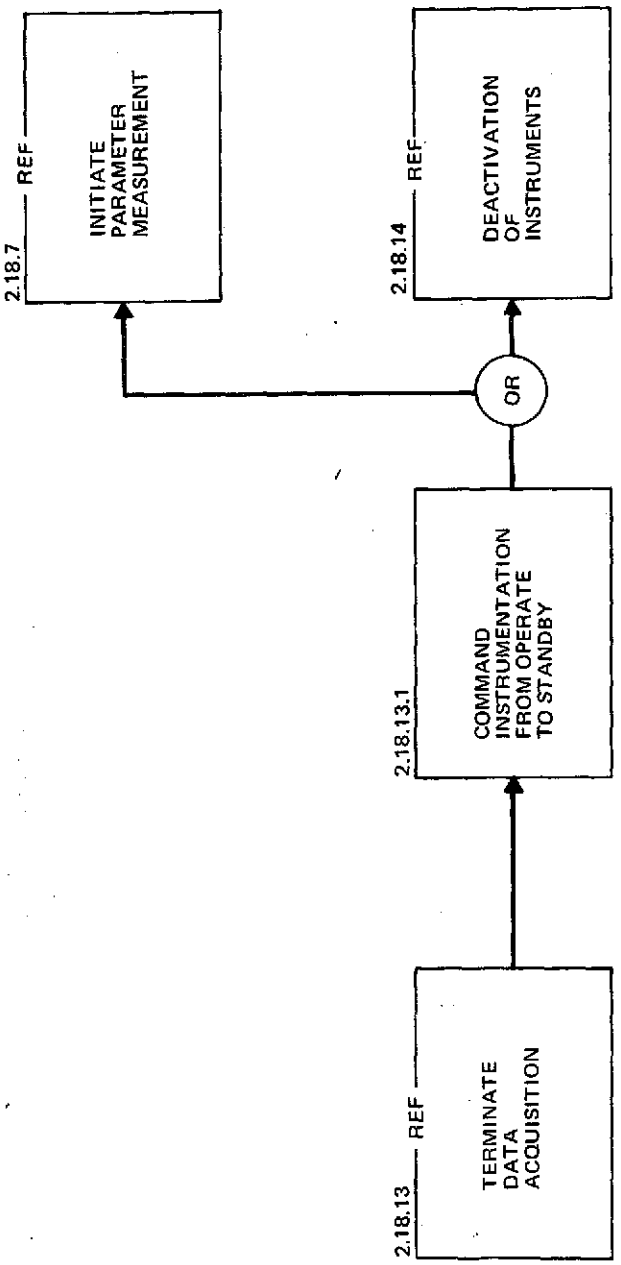


Level III–2.18.11 Data Transmission thru TDRS



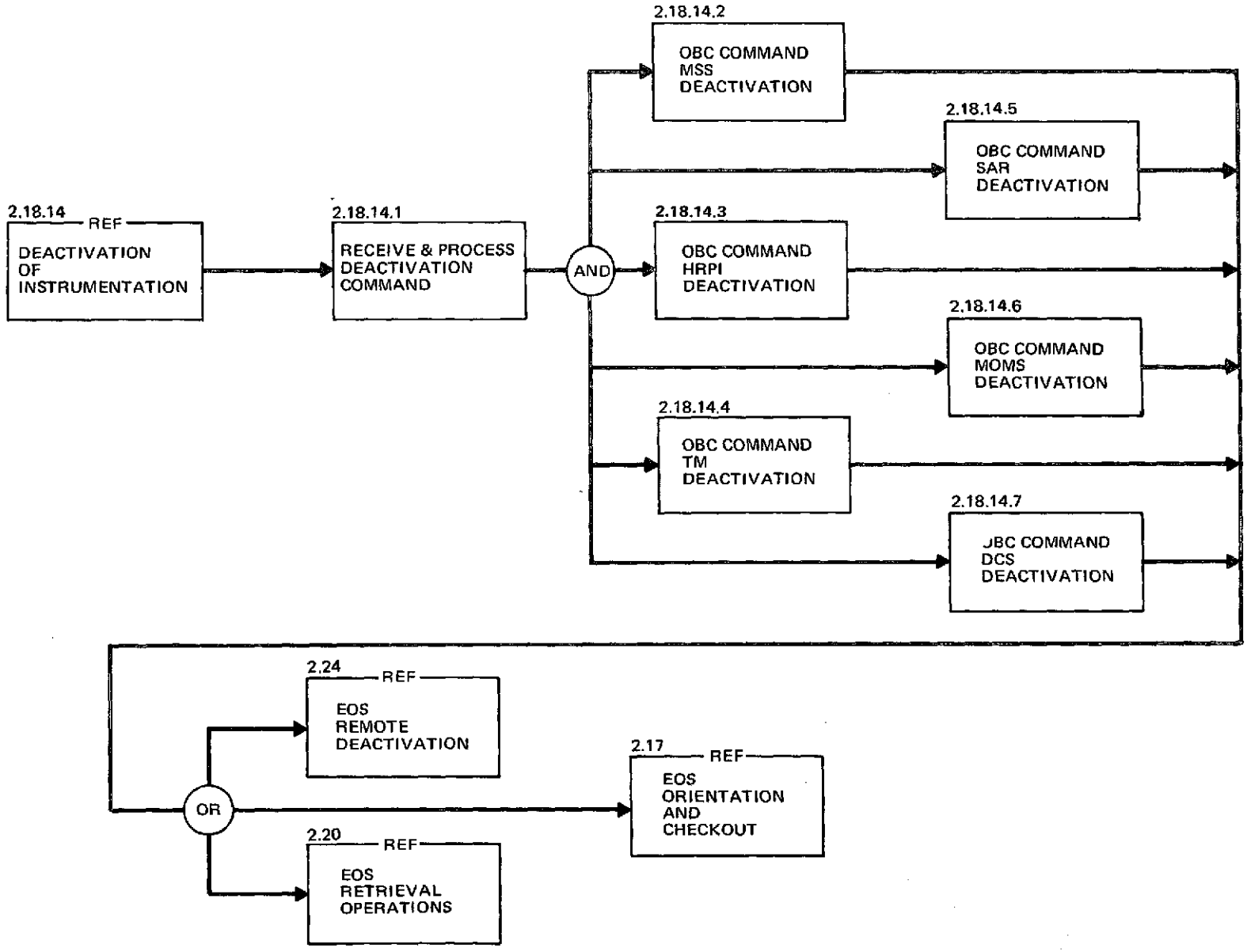
3B-37

Level III—2.18.12 Direct Data Transmission to STDN and LCGS

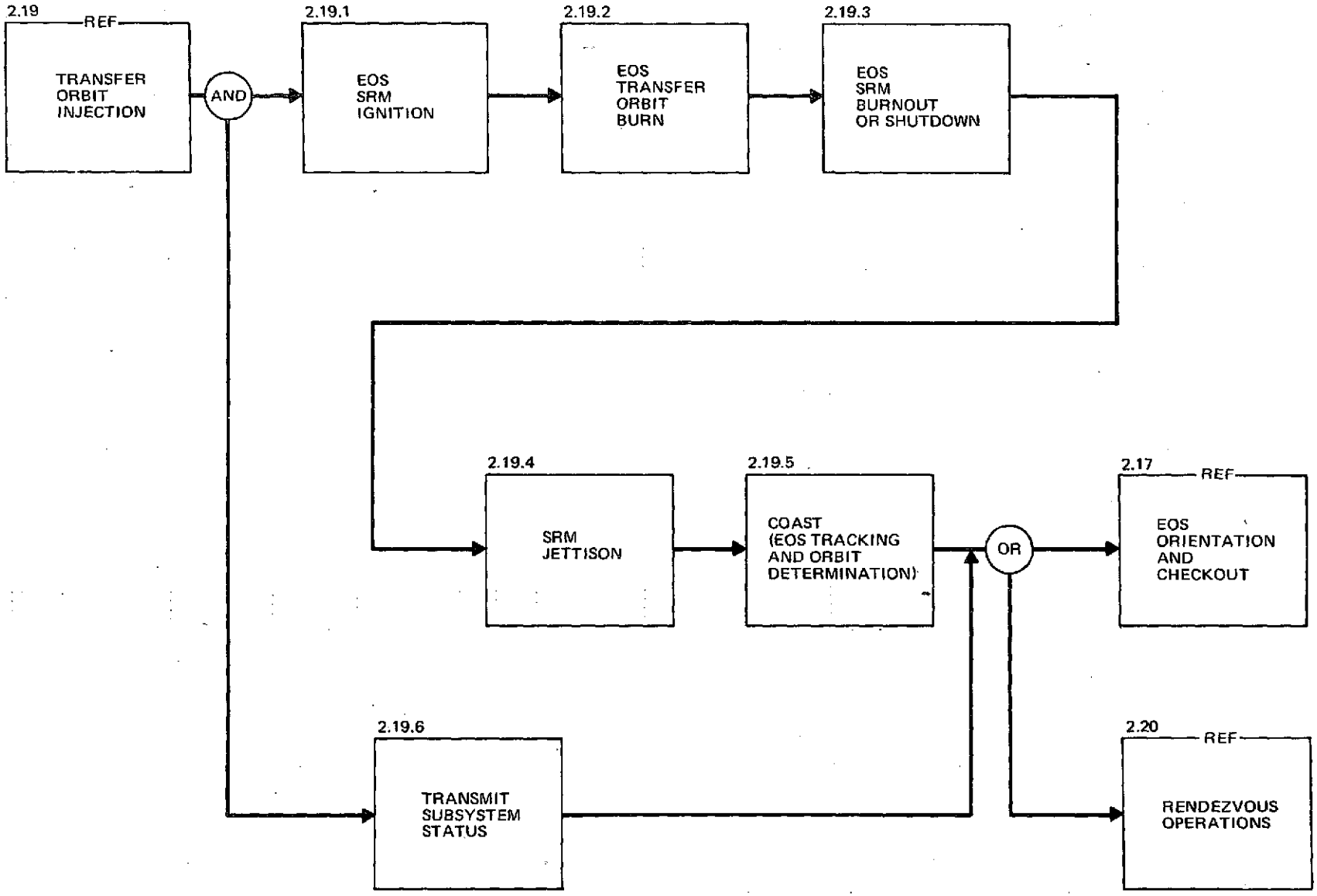


3B-38

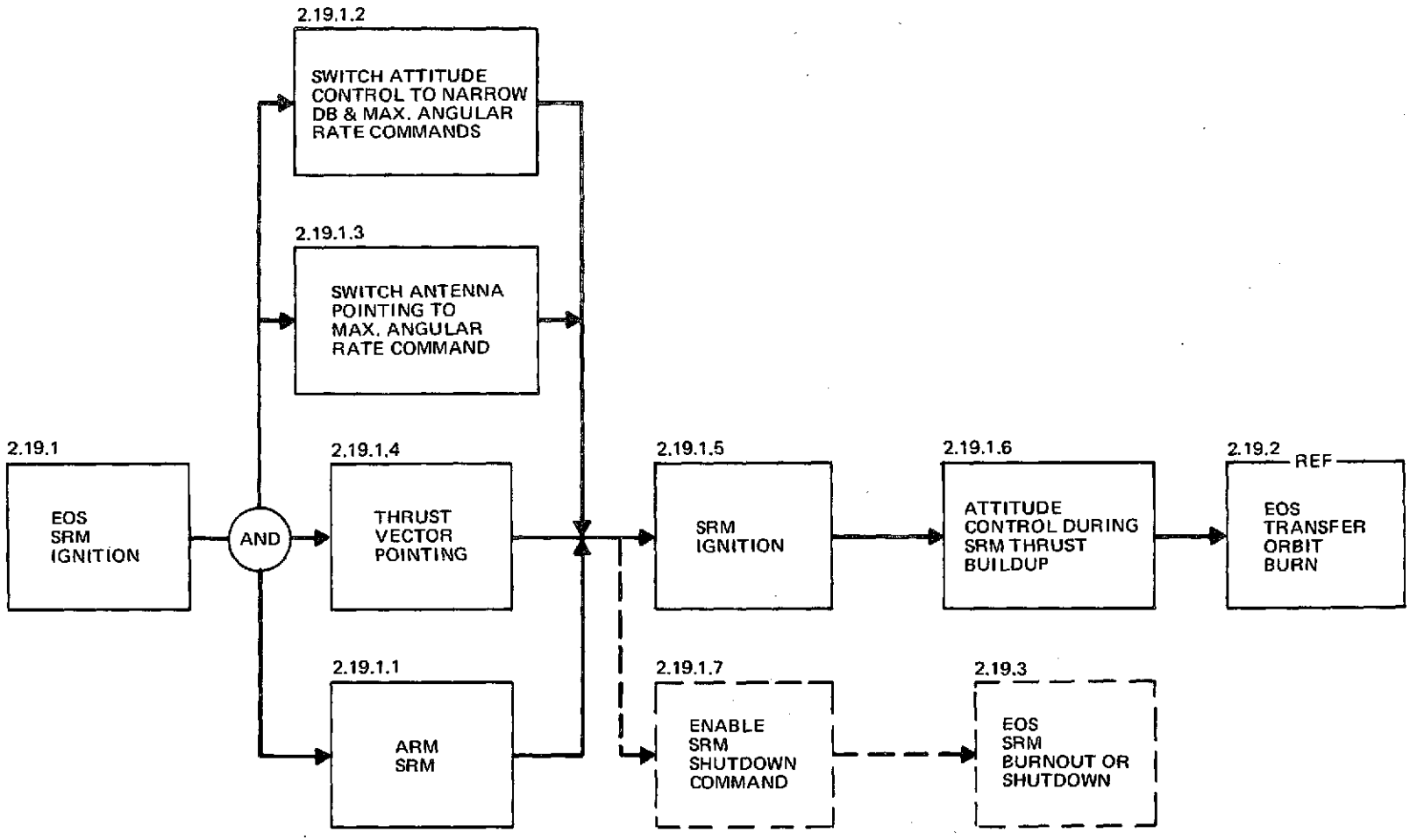
Level III—2.18.13 Terminate Data Acquisition



Level III—2.18.14 Deactivation of Instrumentation

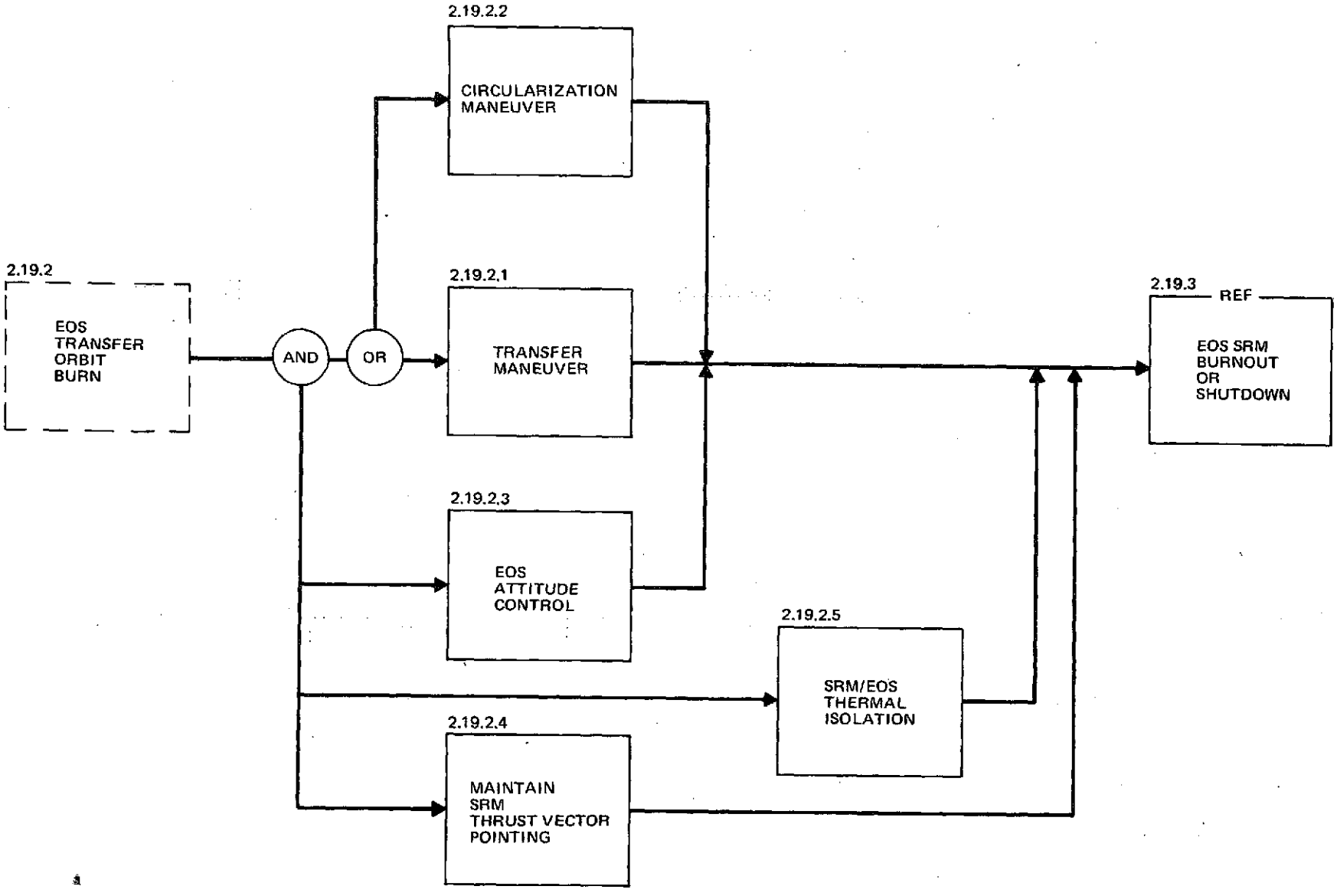


Level II–2.19 Transfer Orbit Injection

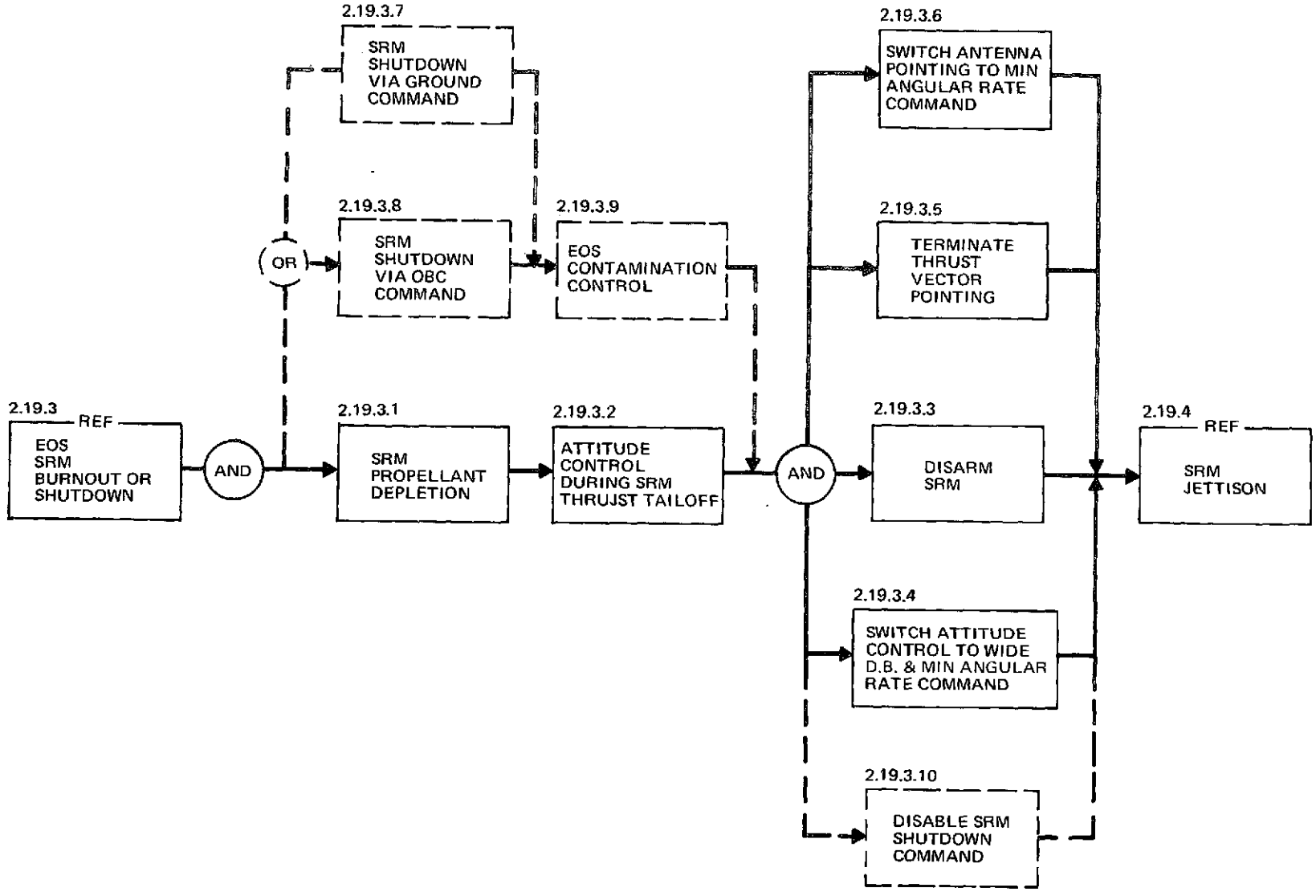


3B-41

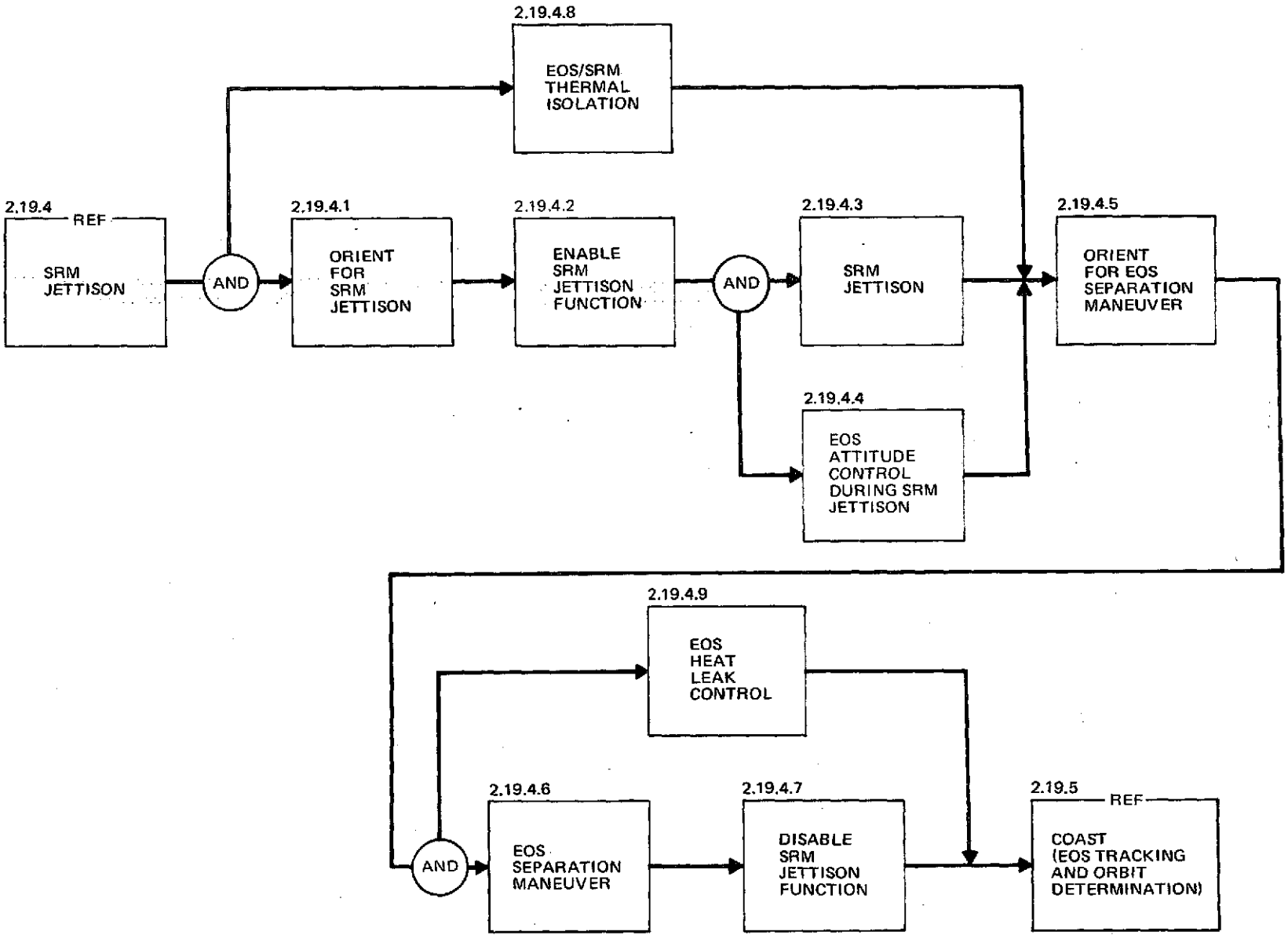
Level III–2.19 EOS SRM Ignition



Level III–2.19.2 EOS Transfer Orbit Burn

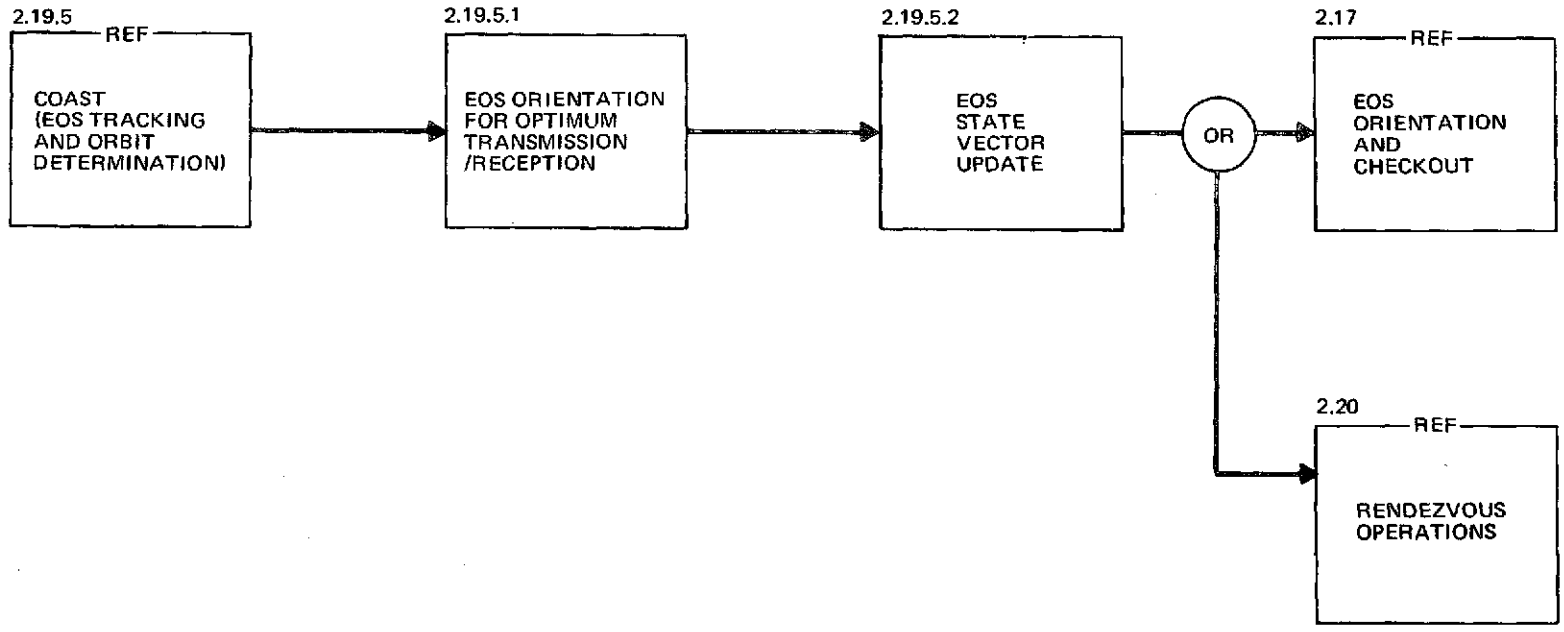


Level III–2.19.3 EOS SRM Burnout or Shutdown



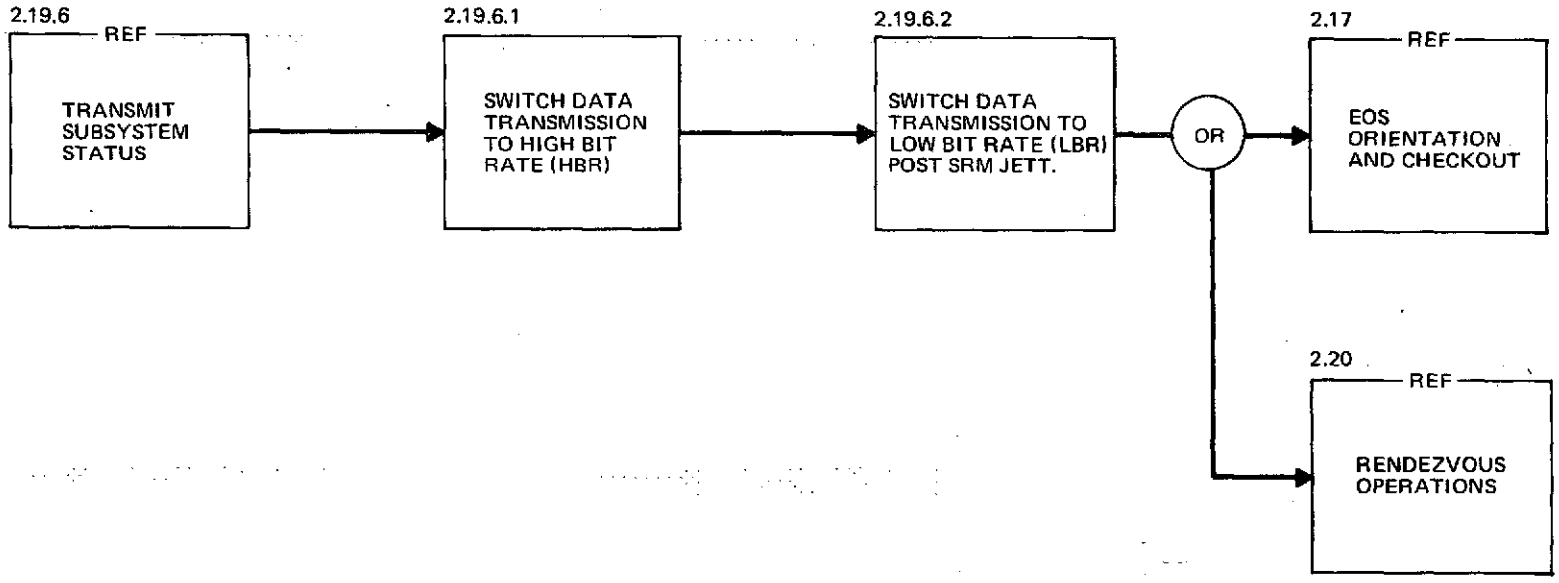
3B-44

Level III—2.19.4 SRM Jettison

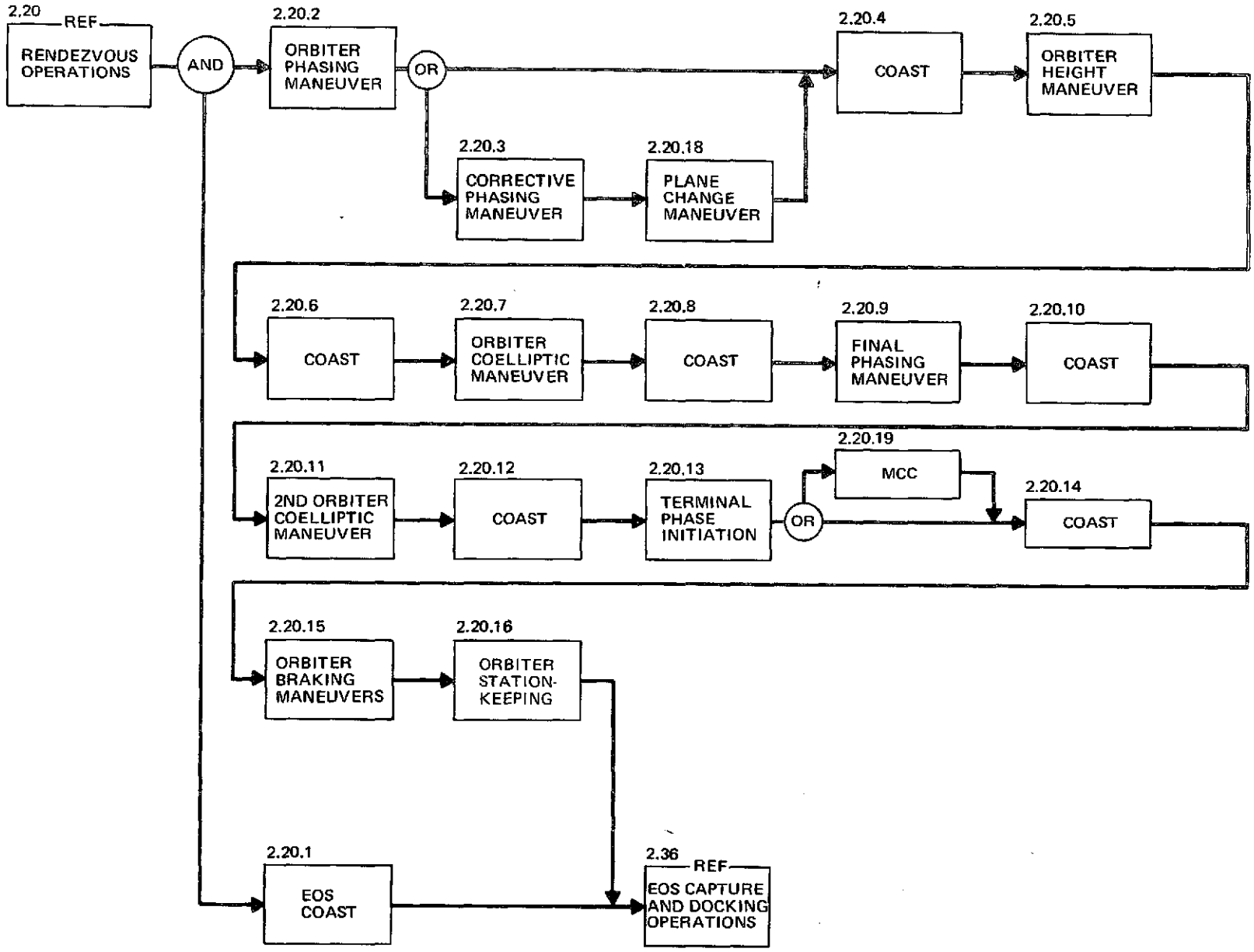


3B-45

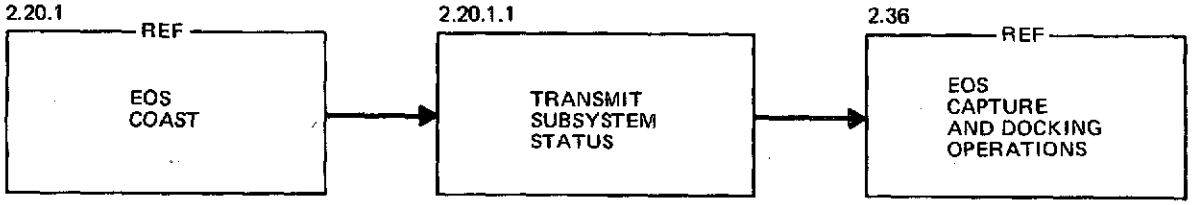
Level III—2.19.5 Coast (EOS Tracking and Orbit Determination)



Level III–2.19.6 Transmit Subsystem Status

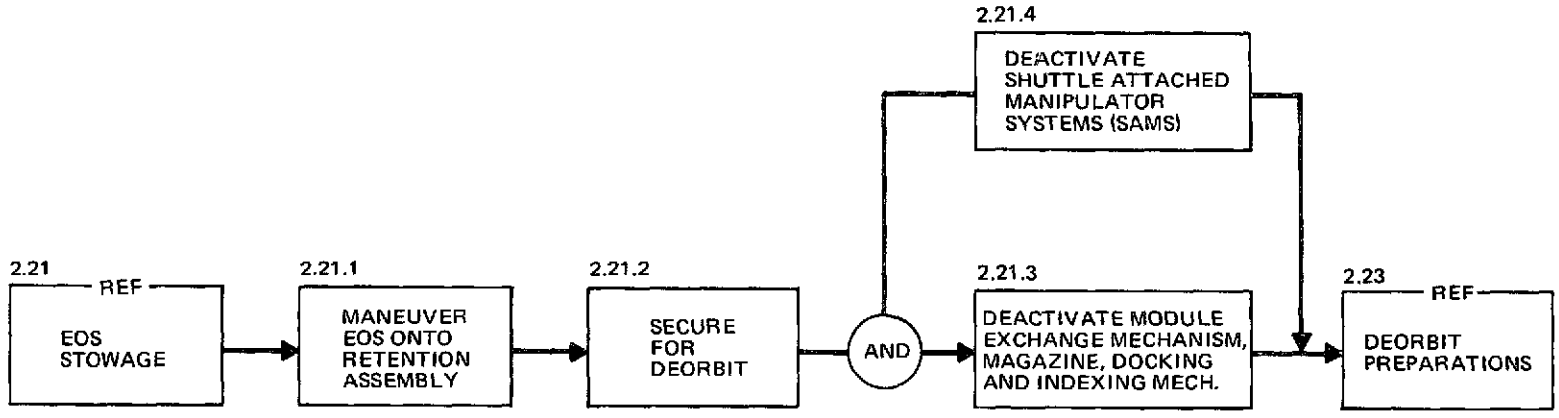


Level II—2.20 Rendezvous Operations



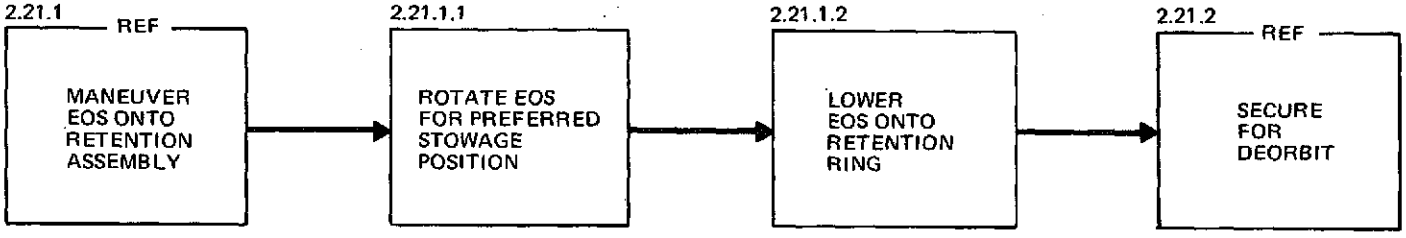
3B-48

Level III—2.20.1 EOS COAST

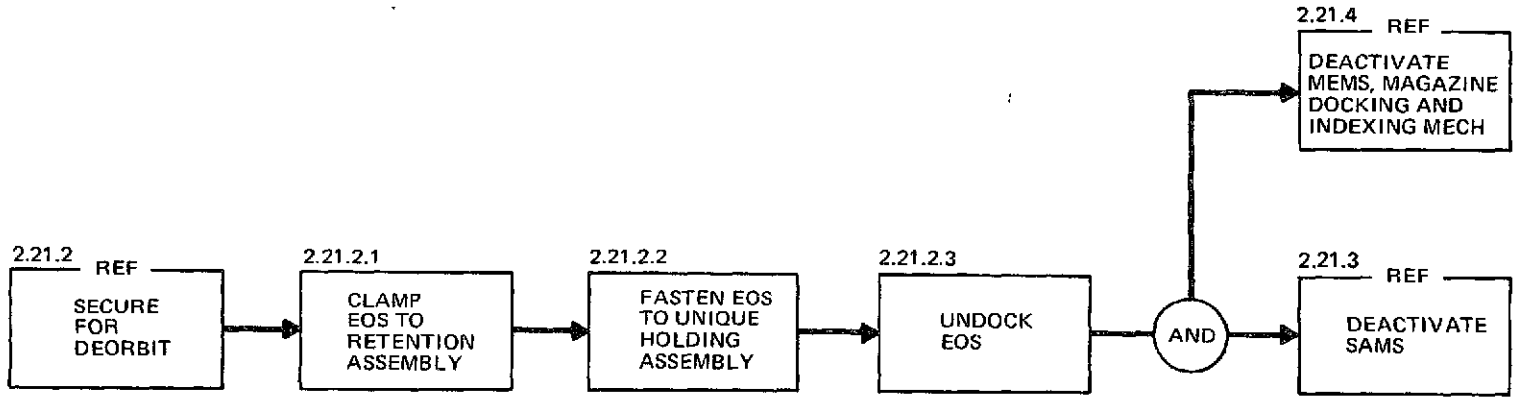


3B-49

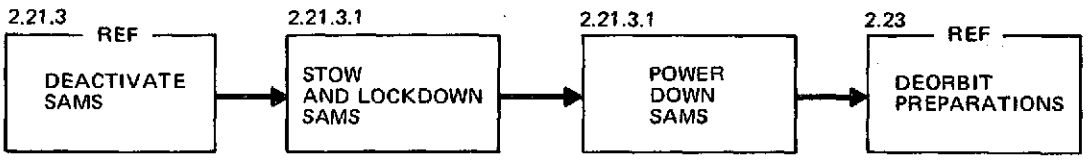
Level III–2.21 EOS Stowage



Level III–2.21.1 Maneuver EOS Onto Retention Assembly

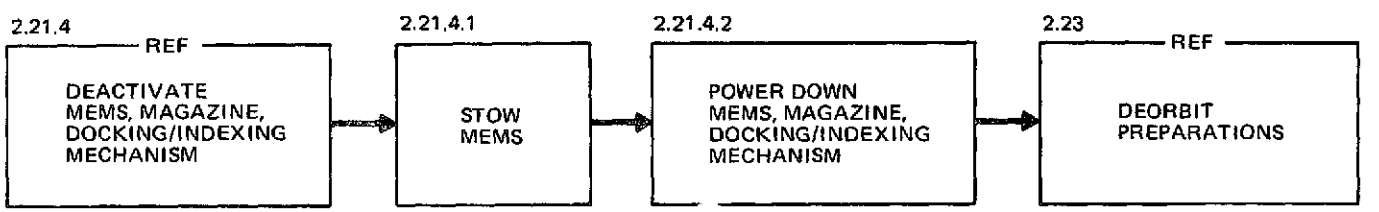


Level III—2.21.2 Secure For Deorbit



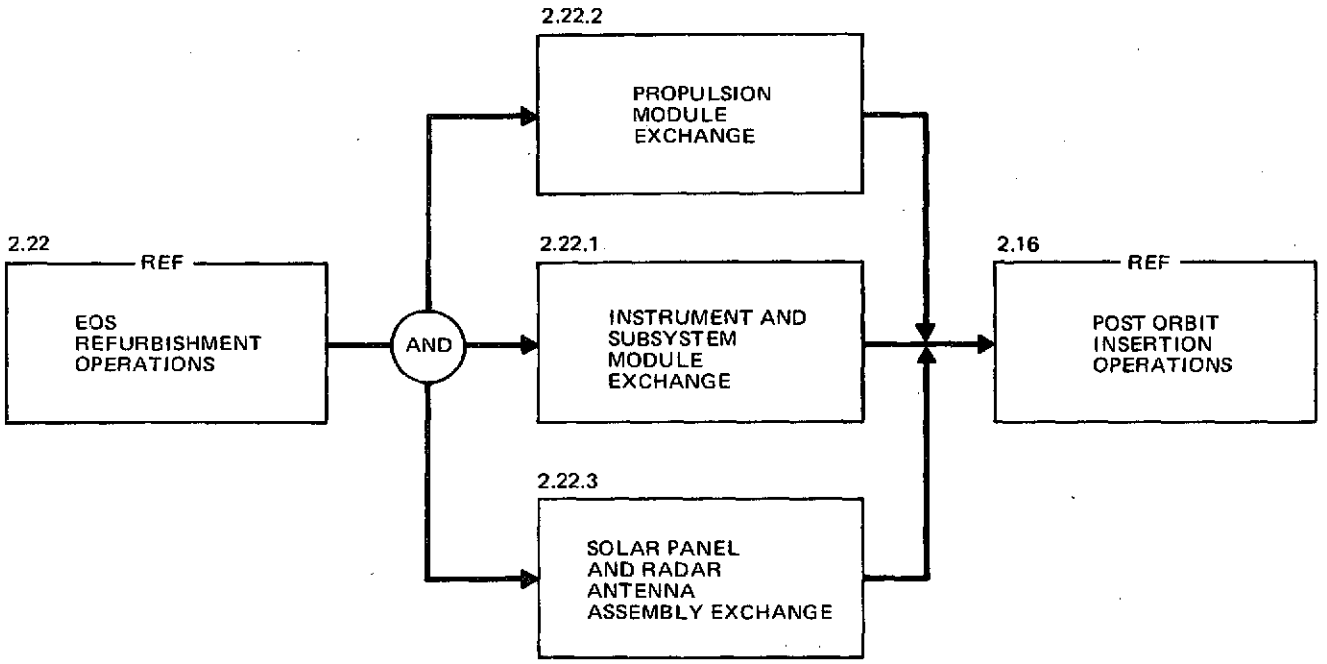
3B-52

Level III–2.21.3 Deactivate SAMS



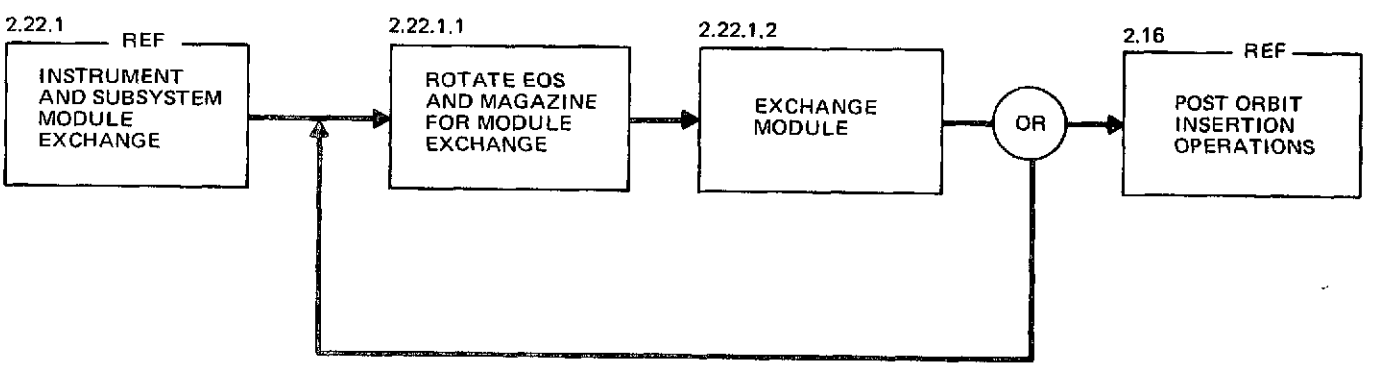
3B-53

Level III–2.21.4 Deactivate MEMS, Magazine, Docking/Indexing Mechanism



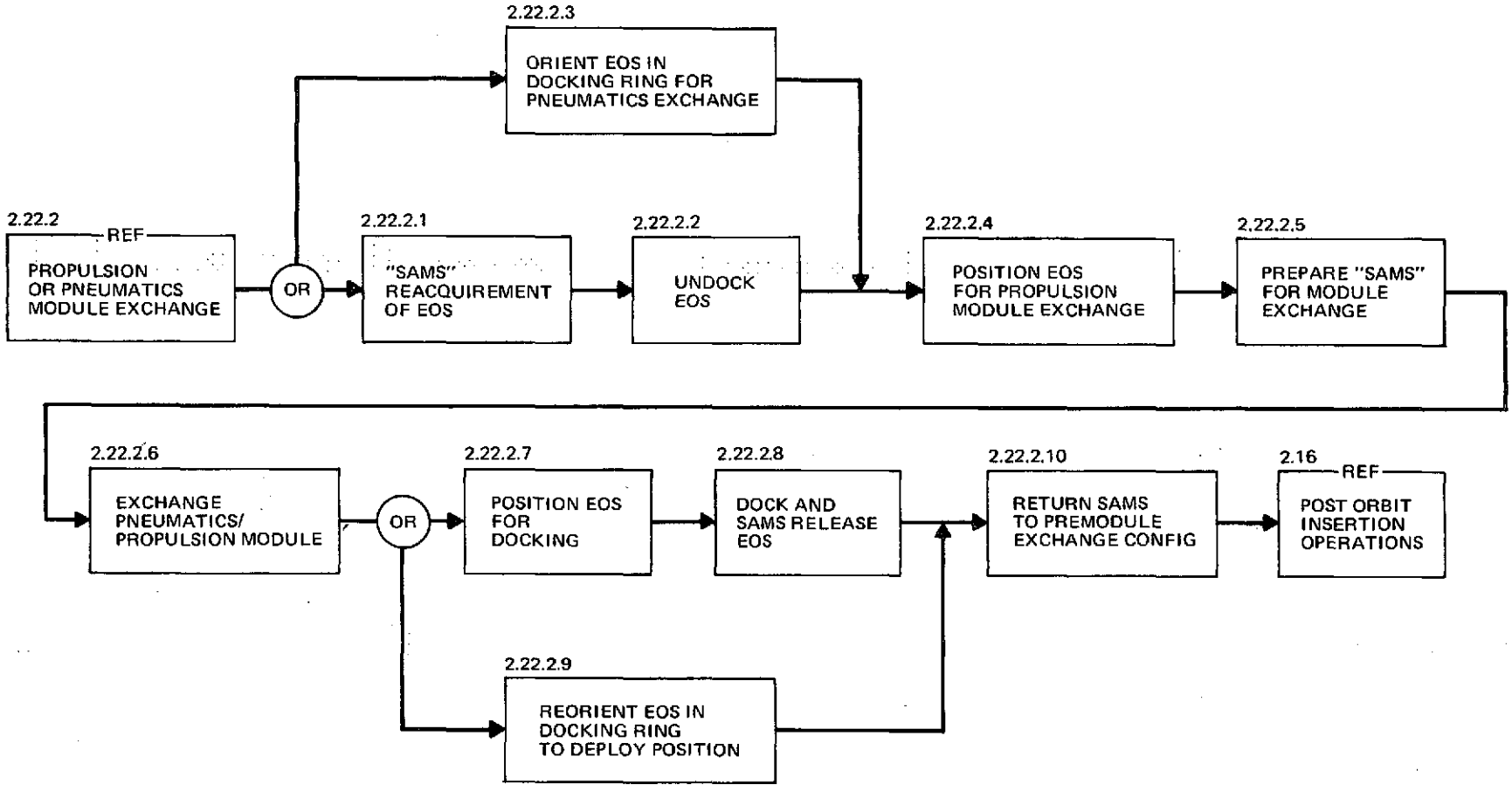
3B-54

Level II–2.22 EOS Refurbishment Operations

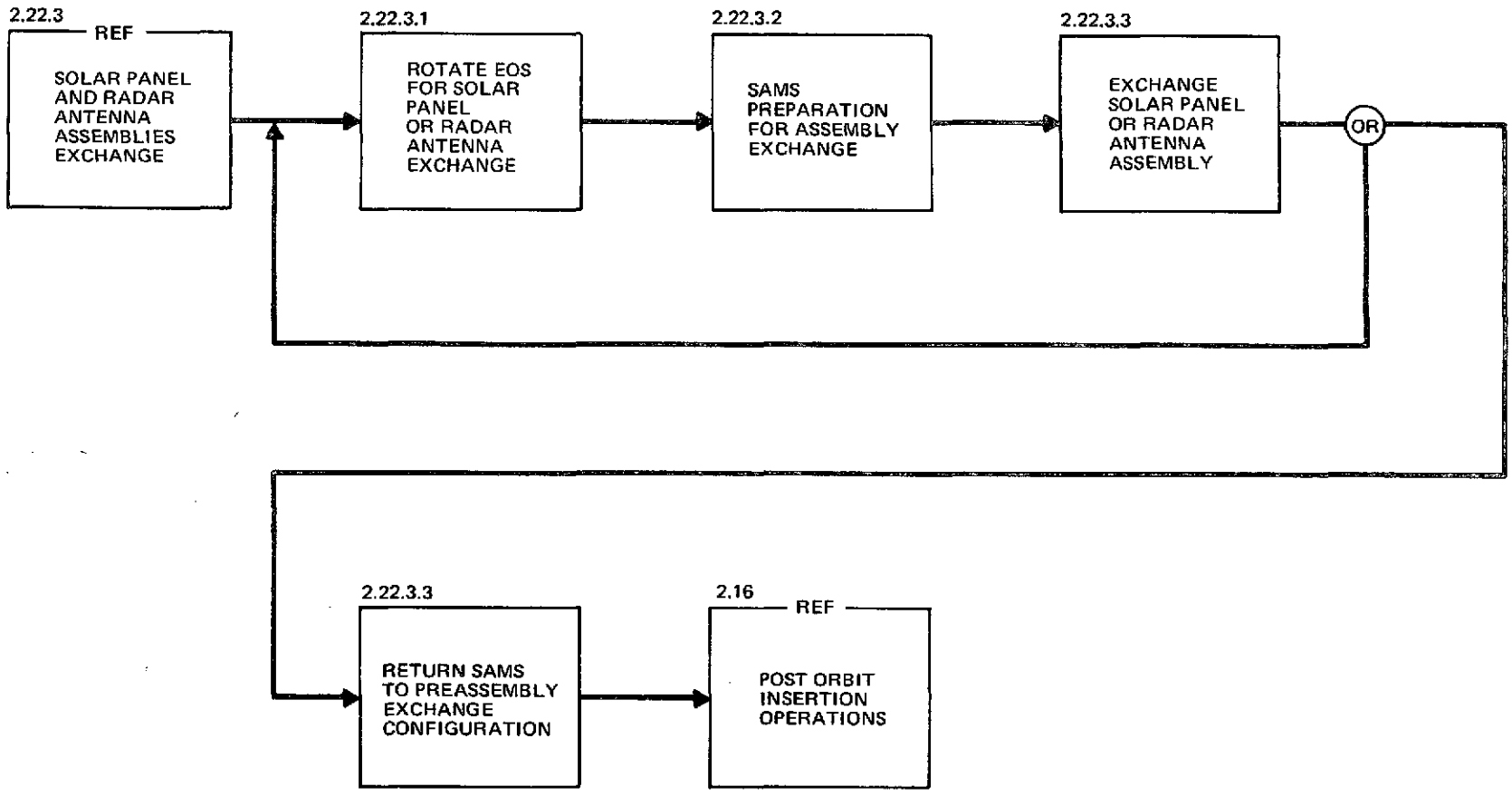


3B-55

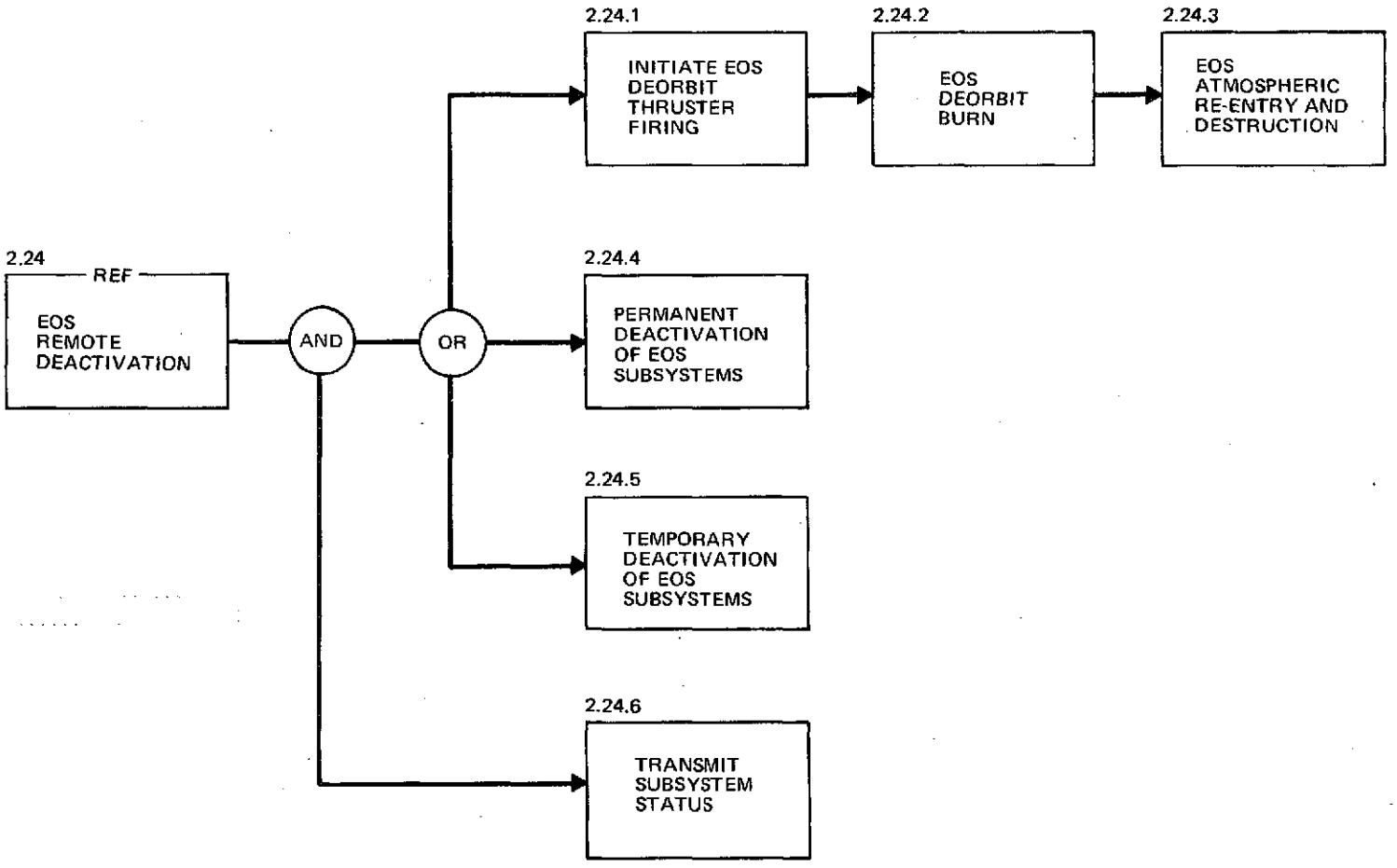
Level III–2.22.1 Instrument and Subsystem Module Exchange



Level III–2.22.2 Propulsion or Pneumatics Module Exchange

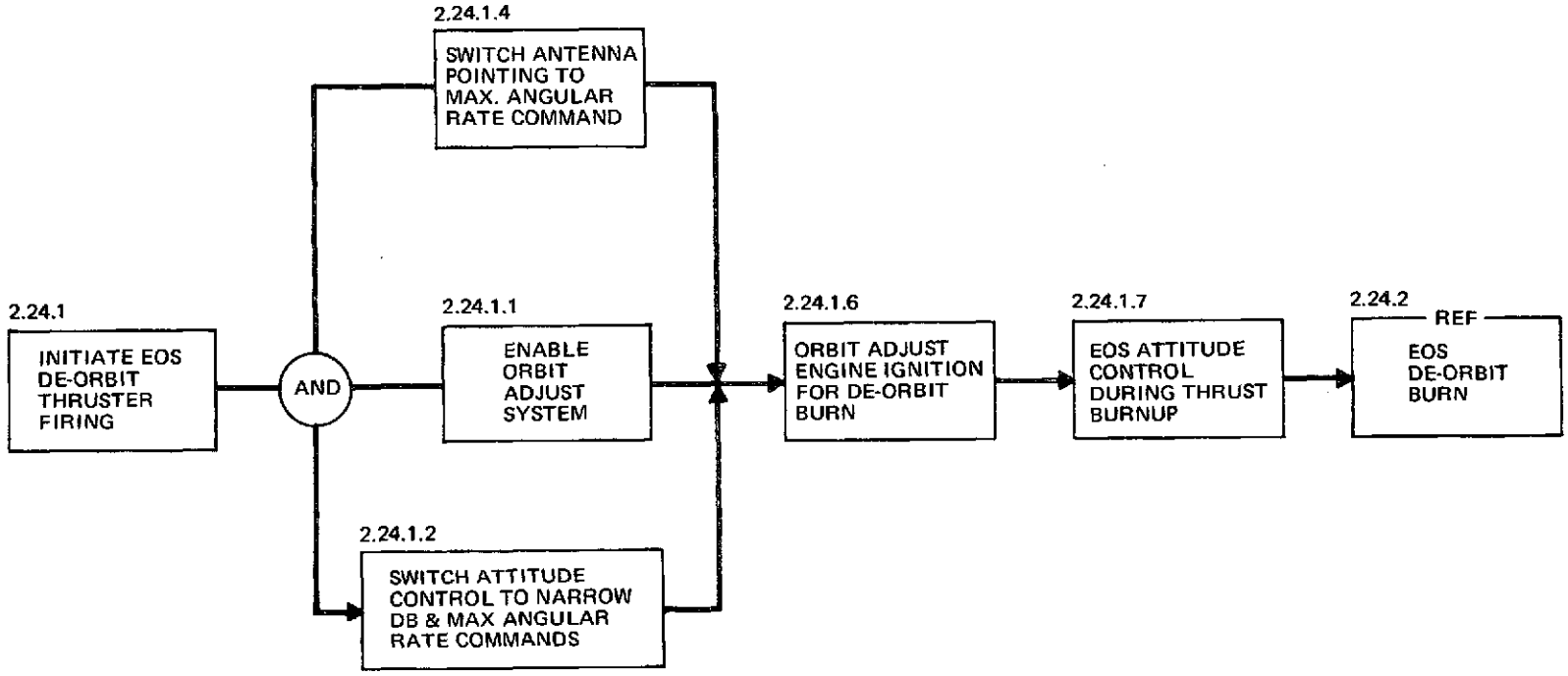


Level III—2.22.3 Solar Panel and Radar Antenna Assemblies Exchange



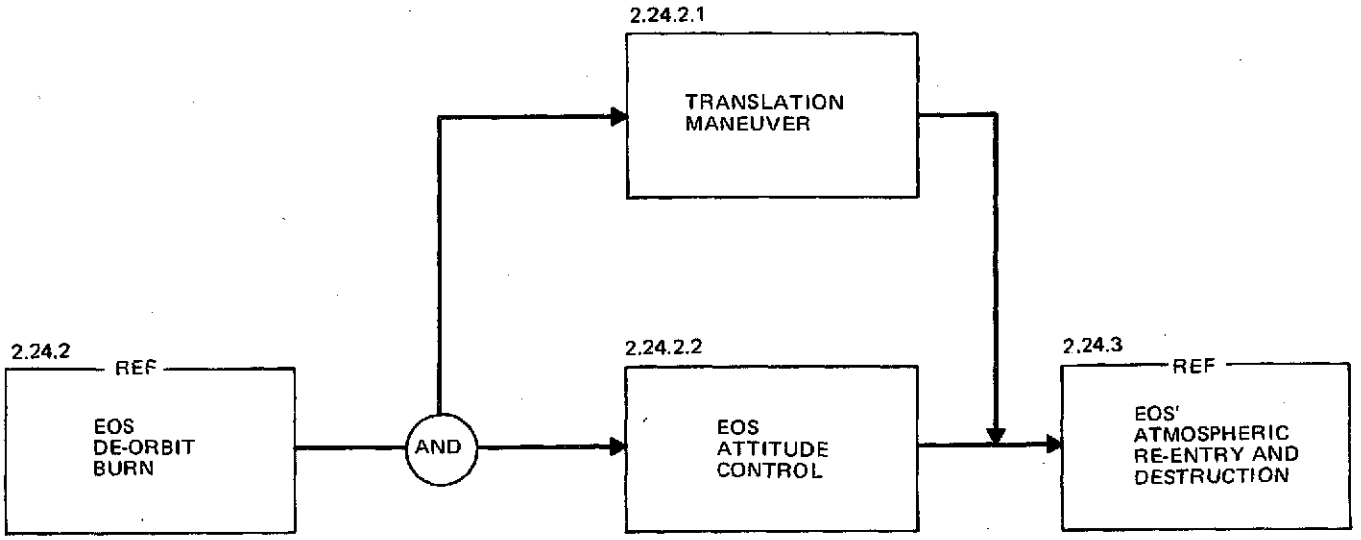
3B-58

Level II—2.24 EOS Remote Deactivation



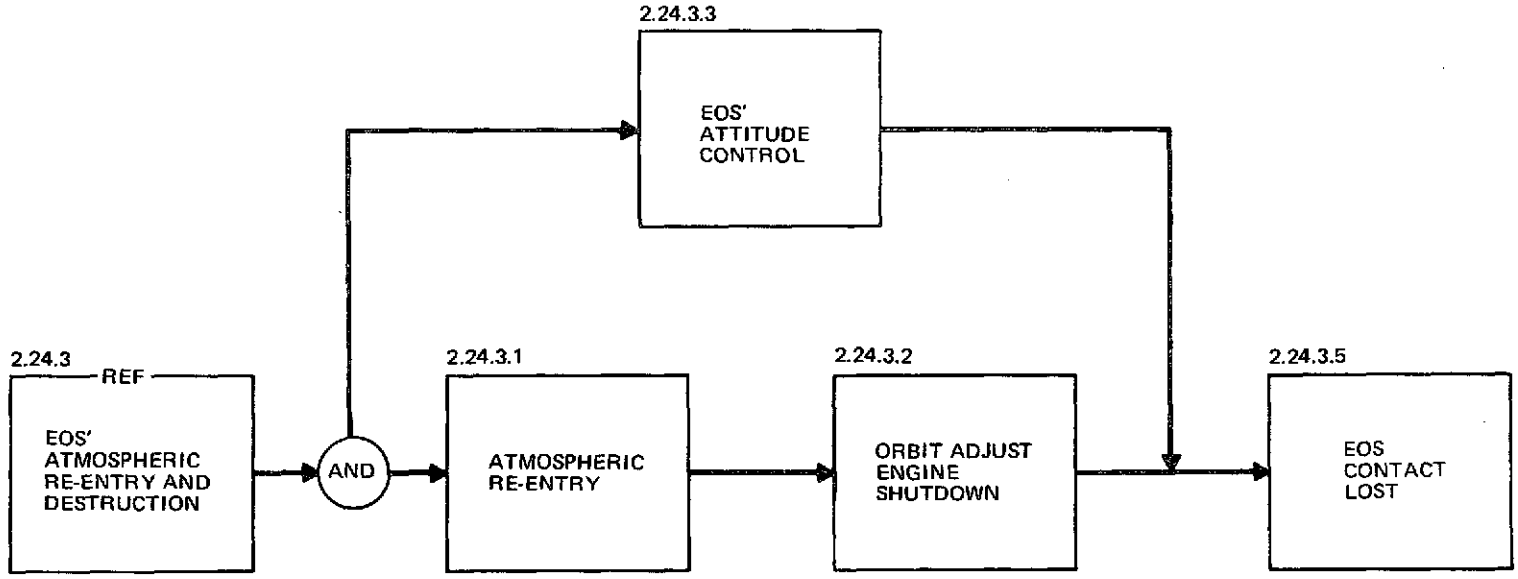
3B-59

Level III–2.24.1 Initiate EOS De-Orbit Thruster Firing



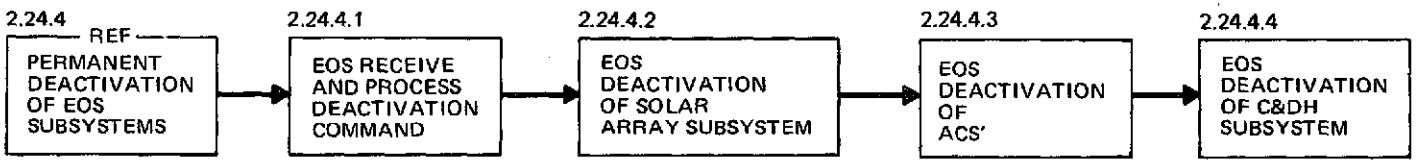
3B-60

Level III–2.24.2 EOS De-Orbit Burn



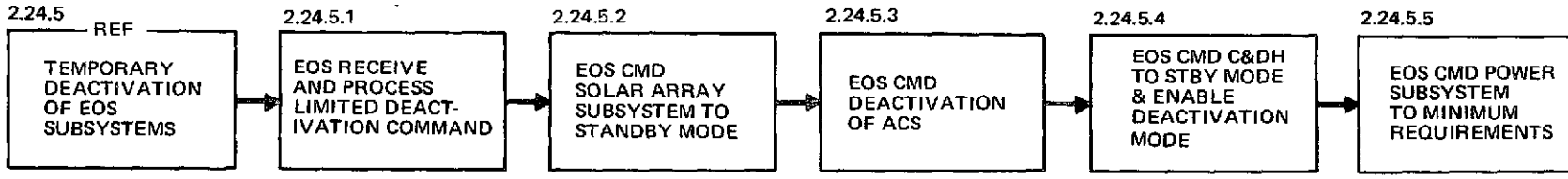
3B-61

Level III–2.24.3 EOS Atmospheric Re-Entry and Destruction



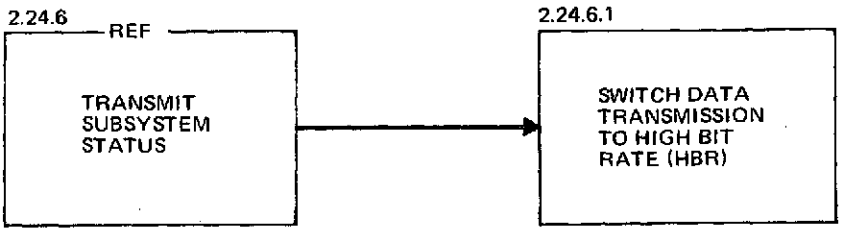
3B-62

Level III–2.24.4 Permanent Deactivation of EOS Subsystems



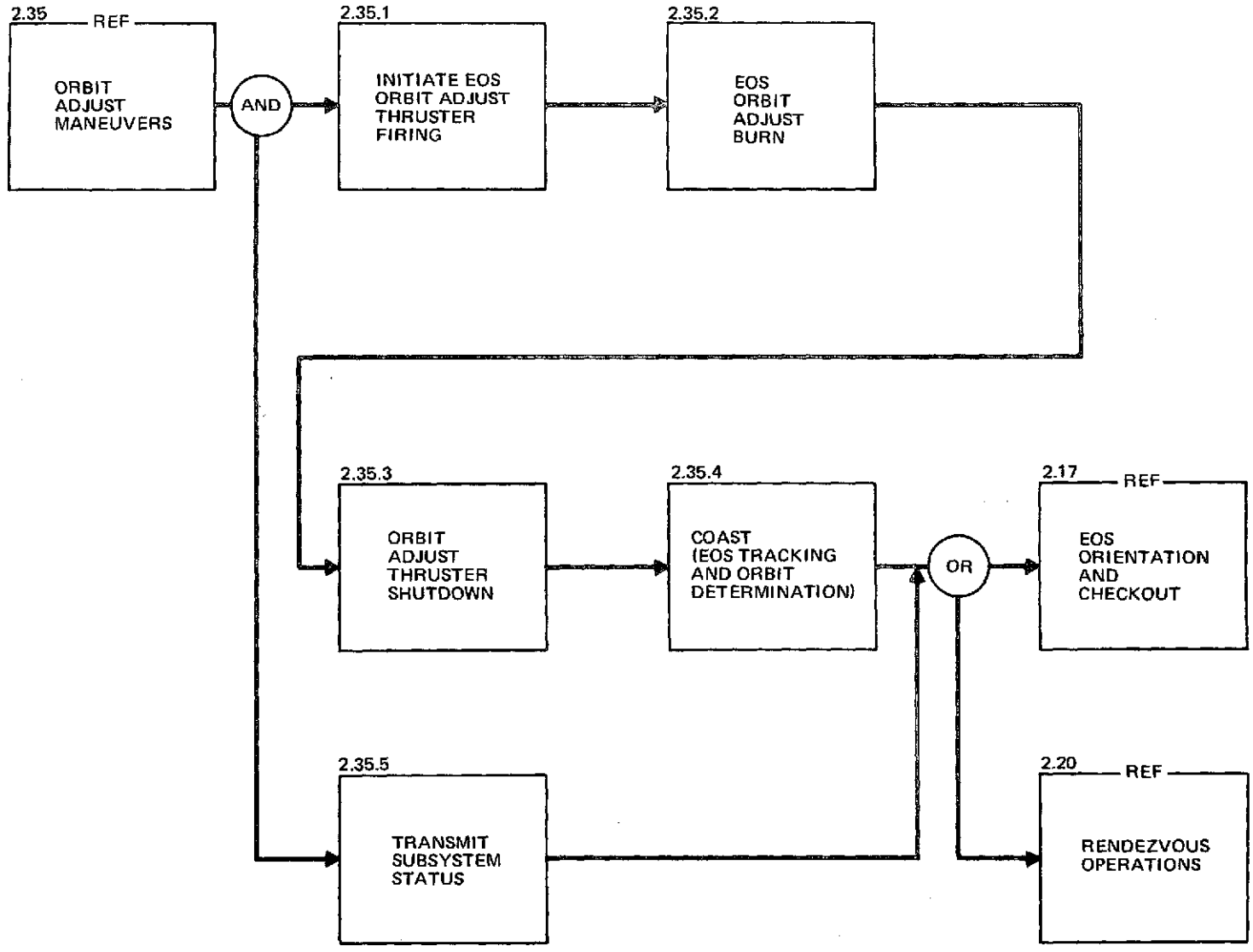
3B-62

Level III—2.24.5 Temporary Deactivation of EOS Subsystems

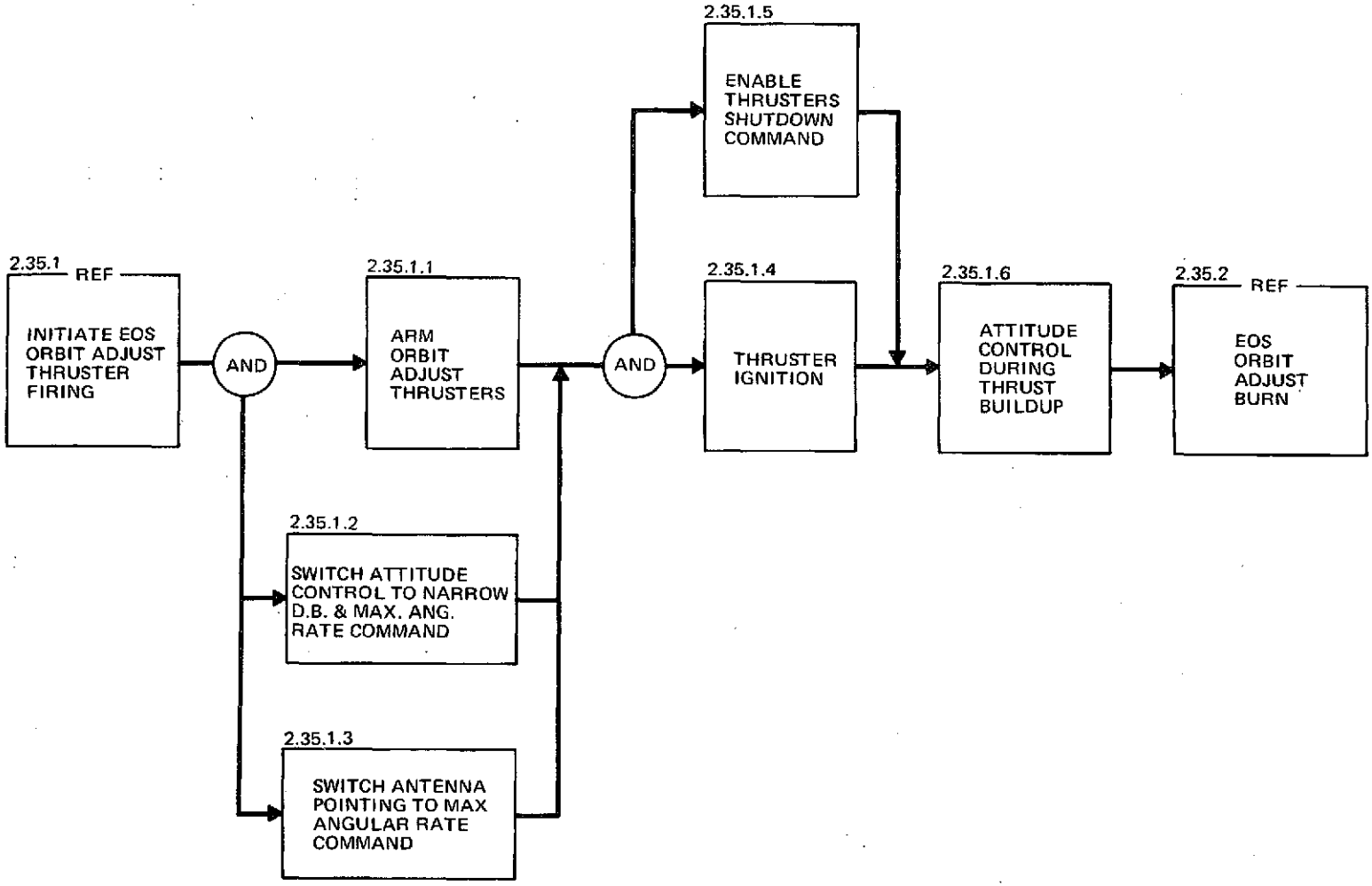


3B-64

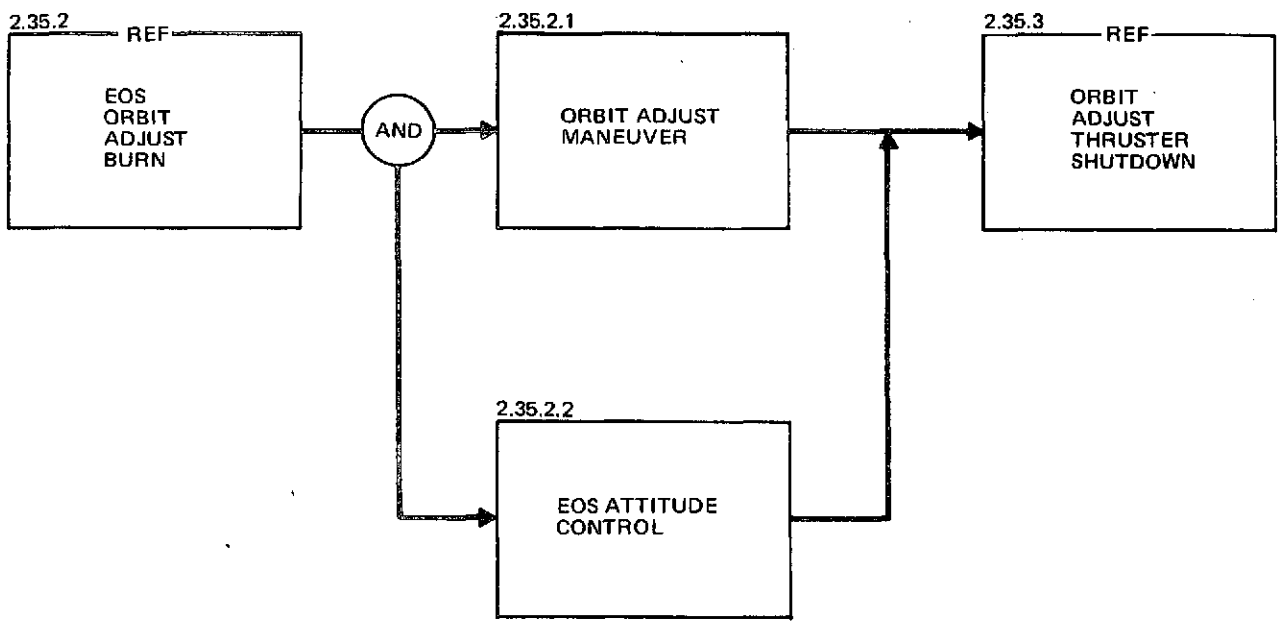
Level III–2.24.6 Transmit Subsystem Status



LEVEL II – 2.35 ORBIT ADJUST MANEUVERS



LEVEL III – 2.35.1 INITIATE EOS ORBIT ADJUST THRUSTER FIRING



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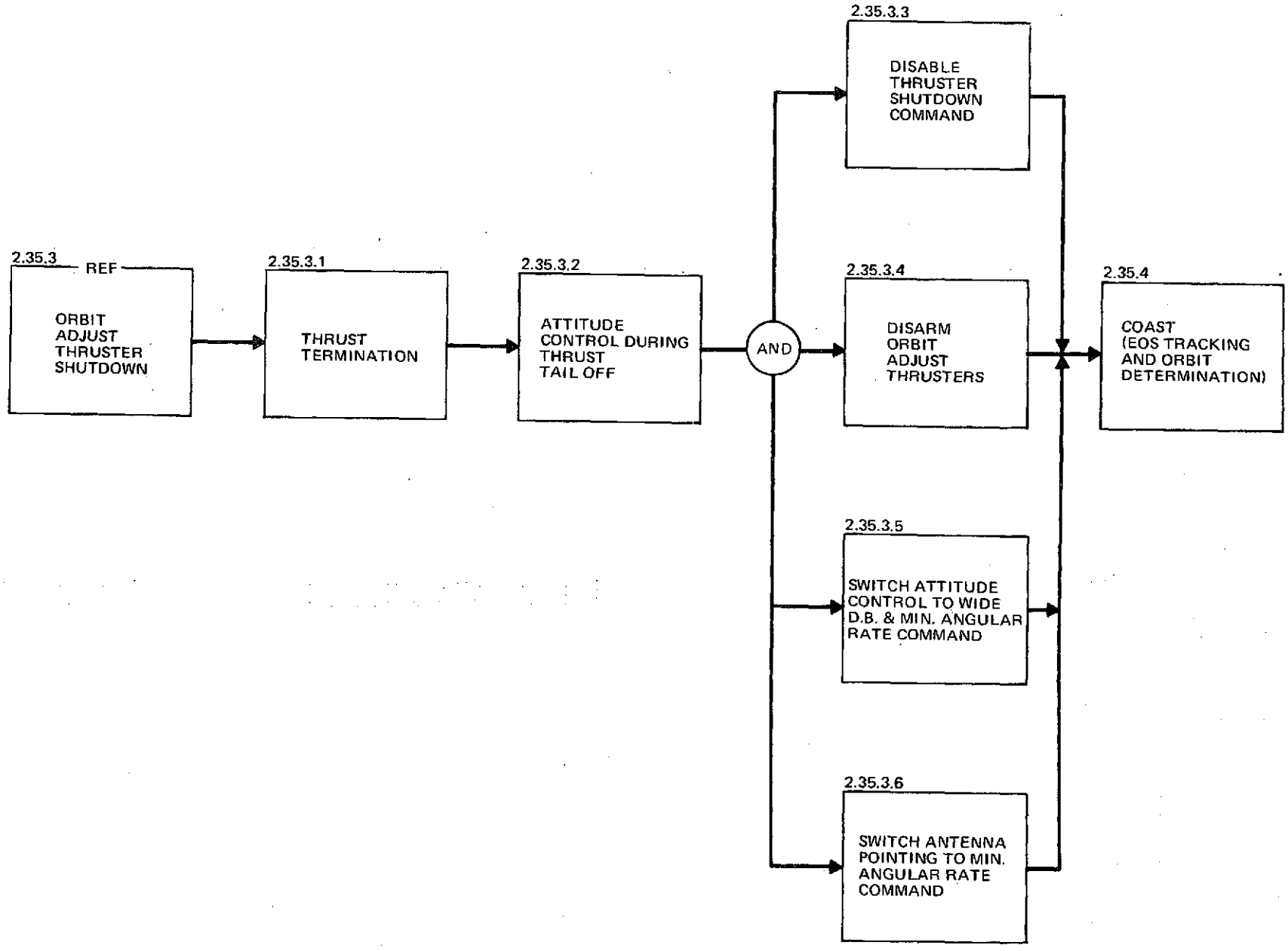
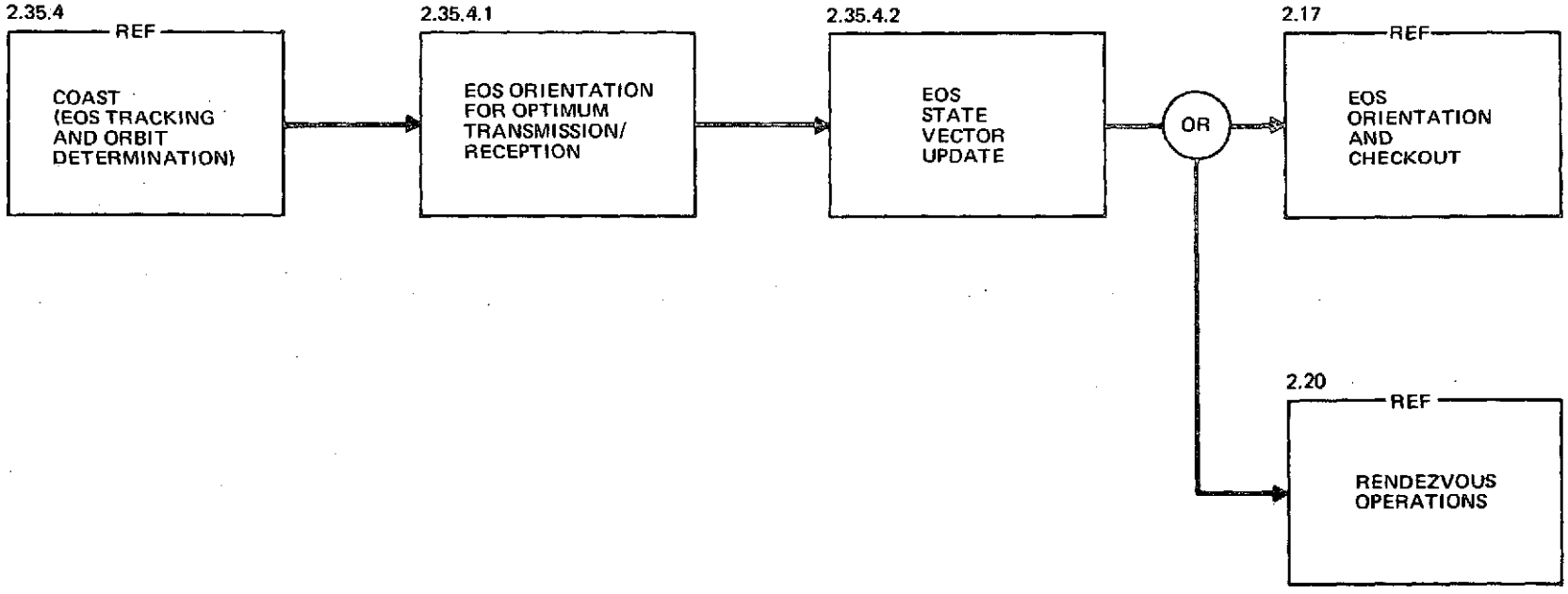
LEVEL III – 2.35.2 EOS ORBIT ADJUST BURN



LEVEL III – 2.35.3 ORBIT ADJUST THRUSTER SHUTDOWN



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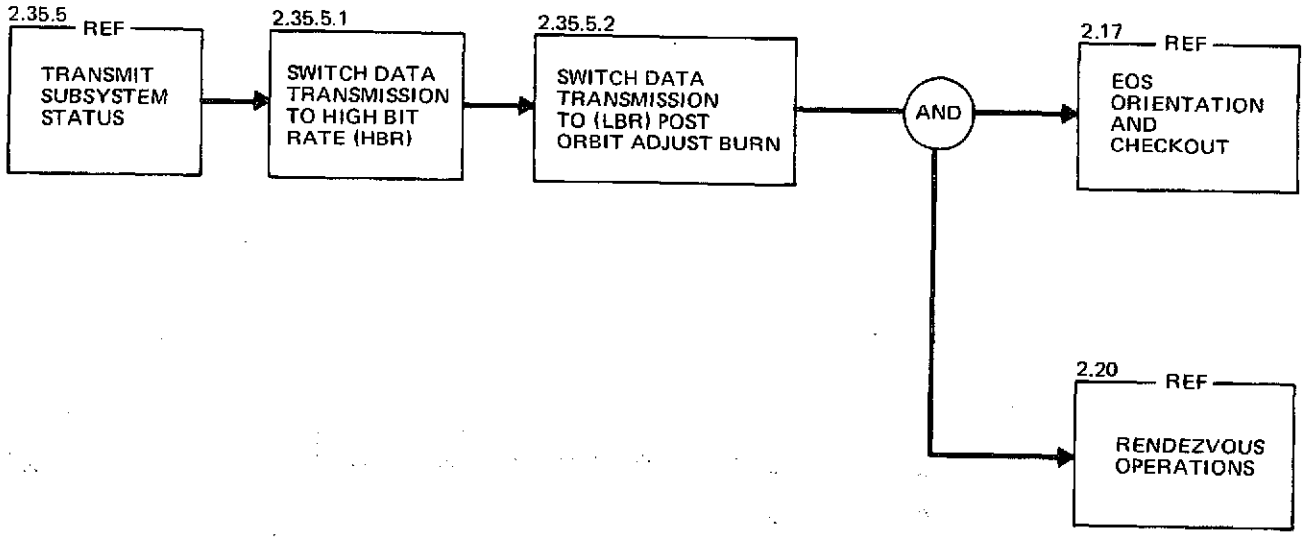
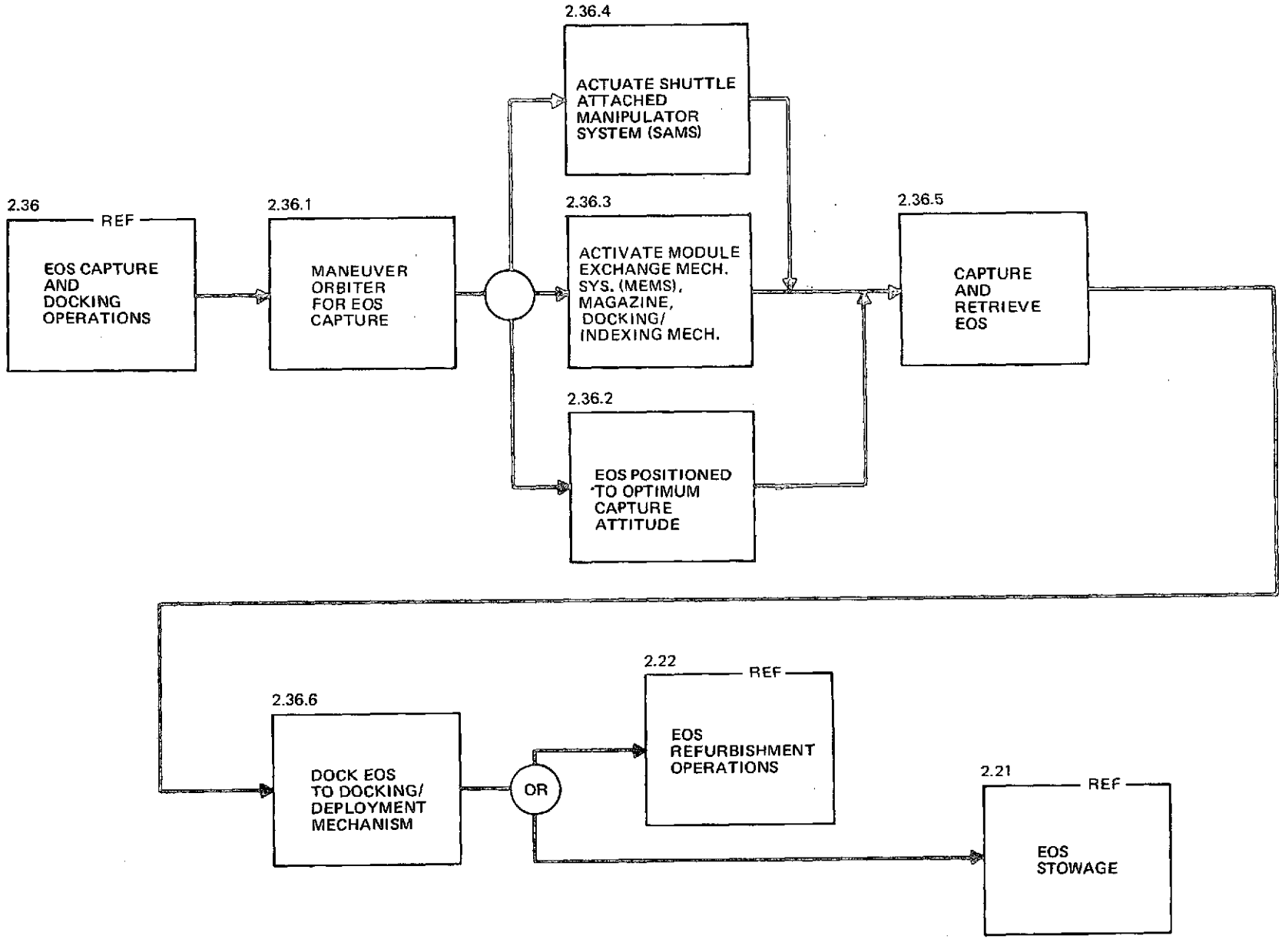
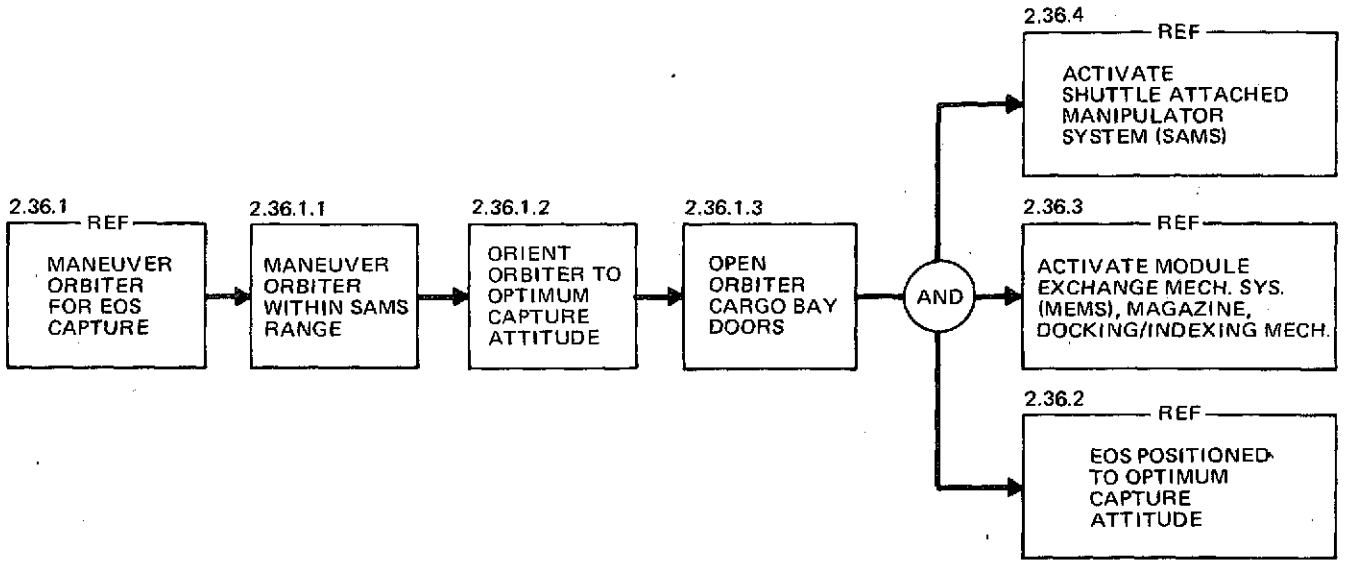
LEVEL III – 2.35.4 COAST (EOS TRACKING AND ORBIT DETERMINATION)



LEVEL III – 2.35.5 TRANSMIT SUBSYSTEM STATUS

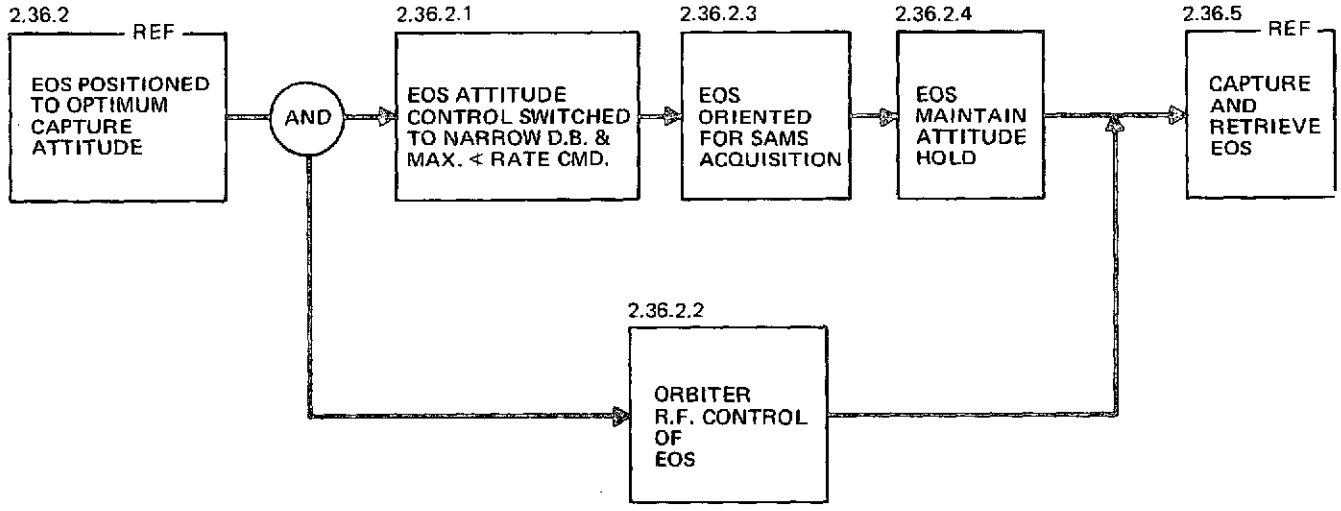


Level II – 2.36 EOS Capture and Docking Operations



38-72

Level III – 2.36.1 Maneuver Orbiter For EOS Capture



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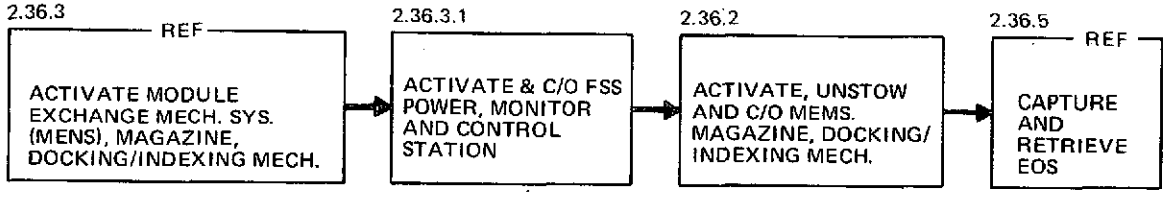
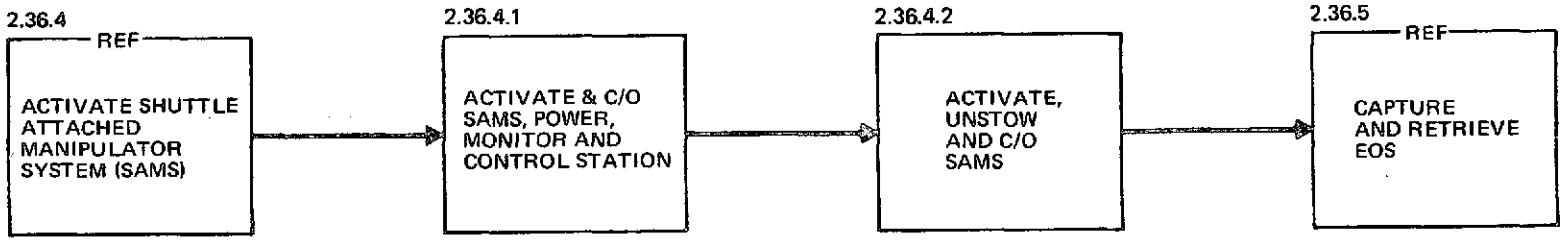
Level III — 2.36.2 EOS Positioned to Optimum Capture Attitude



3B-74 **Level III – 2.36.3 Activate Module Exchange Mechanism; Magazine, Docking/Indexing Mech.**



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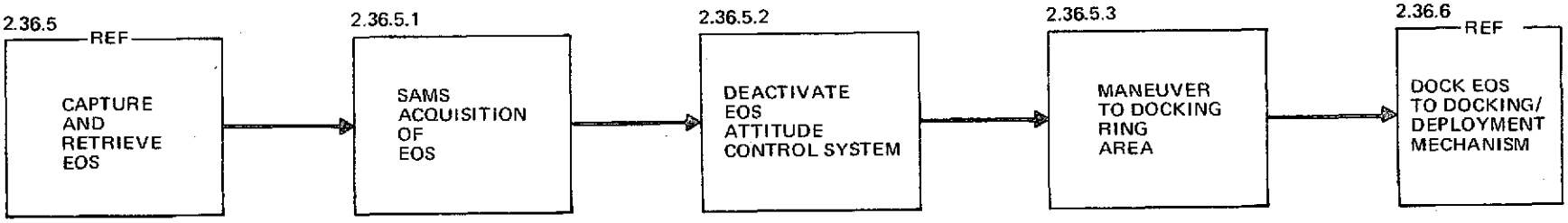
LEVEL III – 2.36.4 ACTIVATE SHUTTLE ATTACHED MANIPULATOR SYSTEM (SAM)



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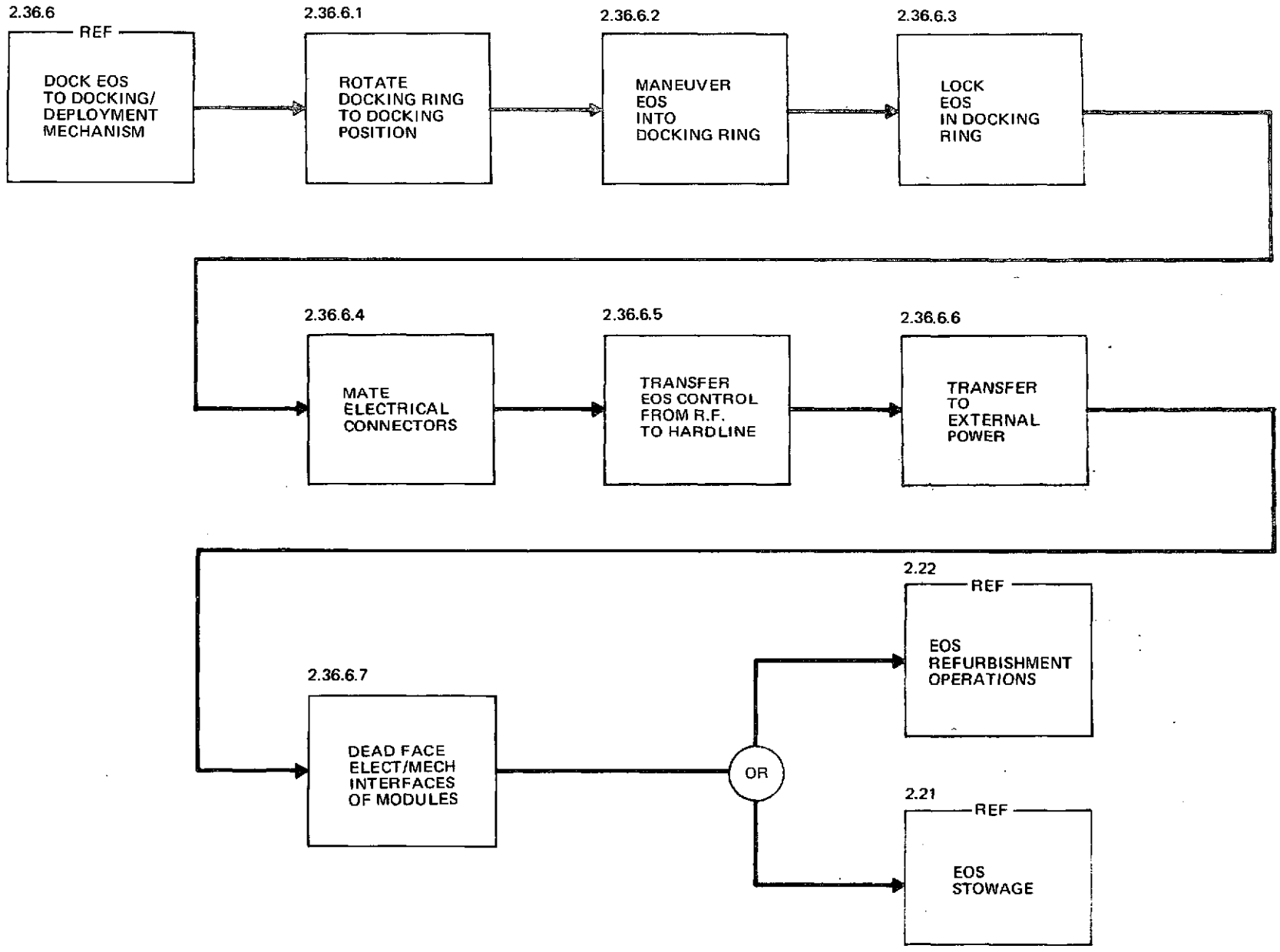
LEVEL III – 2.36.5 CAPTURE AND RETRIEVE EOS



3B-77

LEVEL III – 2.36.6 DOCK EOS TO DOCKING/DEPLOYMENT MECHANISM